ENGINEERING NEWS

THE Board of Engineers appointed to report as to the improvement of the harbor of Philadelphia, and the removal of three small islands in the Delaware, have reported that the plan is feasible, and estimate the cost at $3,000,000 to $4,000,000. Smith's and Windmill islands will be entirely removed, and both shore lines advanced 300 ft. beyond their present position; the lower part only of Petty's Island being removed.

The total amount of material to be moved is some 400,000 cu. yds. It is the intention to have about 26 ft. at low water on the western side of the channel. It is brought forward in opposition that Philadelphia has done almost nothing for its own harbor but has relied solely on government aid, whereas Baltimore, Boston and other cities have spent a great deal of their own money on harbor work, but as there are many cities which have done no more than Philadelphia this objection will not weigh much.

THE financial prospects of the Panama canal scheme are discussed by M. LEROY-BEAULIEU in the *Economiste Francais*, with results far from flattering. He says that for the completion of the canal with locks the company will need at least five years time, and certainly an additional $313,000,000. There have already been spent $212,000,000, which will make the total cost of the canal with locks $525,000,000. Regarding the income to be derived from the completed canal, the same writer says that the company may expect to realize a yearly revenue of from $6,000,000 to $7,000,000, which it needs to pay the interest on its bonds alone, to say nothing of the capital stock invested. M. LEROY-BEAULIEU thinks that the companies only resource is to suppress the interest on its shares, reduce the interest on its bonds, and then ask from the great powers such a collective guarantee on the amount to be borrowed that it can be secured for 3 per cent.; in which case, and by much more economical management than formerly, the canal may possibly be finished for $220,000,000. It is of course absurd to suppose that our own or any other Government, except the French, will join in guaranteeing interest on the present obligations already incurred. If the company goes into insolvency and a new one is organized, it may be different.

IN spite of de LESSEP'S favorable vote of about two-thirds in the Chamber of Deputies, the committee of the body to which the question of issuing a lottery loan was referred was equally divided for and against it, and hence was unable to make a report.

THE trestle on the Savannah, Florida & Western Ry., on which the dreadful accident occurred, noted last week, is stated by C. S. WYCKOFF, formerly an engineer in the service of the company, to have been rebuilt within two years, and to have been in thoroughly good condition. The trestle is stated to be of the "inverted W type, which is the strongest known to engineering," although it is certainly not the most approved; and the piling, according to Mr. WYCKOFF, must have been remarkably well done, as it is stated by him that each pile in the trestle bridges, "is driven with a hammer weighing 2,200 lbs. falling 40 ft., until the last blow only moves it 1-8 inch." We have heard of such pile driving in text books, but we have never yet seen it on any railway in America and we are glad to know that it exists somewhere. We have not as yet received any further details concerning the structure, but we are glad to believe that all charges as to the timber being rotten, or the trestle in bad order, are not justified.

THE last steel arch of the new Manhattan bridge over the Harlem river, was successfully completed March 30, without any difficulties. This arch is directly over the river, so the center segments were hoisted from floats moored below. The arms of each rib of the arch were raised a little before the key-segments were introduced; when these were in place and partially connected, the arms of the ribs were lowered, the connections completed, and the last arch settled into its place. The segments were so perfectly made and connected that there is not a variation of one-eight of an inch in the total length of the arch, 508 ft.

The work of erecting the floor-pillars, laying the roadway, etc., will be rapidly pushed. The date of the formal opening of the bridge is uncertain, but probably it will not be until fall.

AN electric street railway was opened for business at Carbondale, Pa., on March 28. The Sprague system is used.

IT is stated that pneumatic tubes will be introduced in Wall St. for the transmission of messages and securities between various points. The gentlemen in the New York Stock Exchange who, according to reports, have organized for this purpose, propose to adopt the system known as the Clay Electric Pneumatic Tube. In this system, automatically closing electric switches are used, which throw the carrier off the main line to deliver the message at any desired office. To exhibit the utility of the project, a complete plant, it is stated, is now being erected in Wall St.

THE earth's heat is being used in a practical way at Pesth, where an artesian well of great depth is being sunk to supply hot water for public baths and other purposes. An article in a foreign journal says that a depth of 8,130 ft. has been reached, which seems almost incredible, the deepest well heretofore having been that at Sperenburg, near Berlin, 4,194 ft. We give the depth stated, therefore, with some reservation, as possibly erroneous, but the well now supplies daily 176,000 gallons of water, heated to 150° Fah.

THE municipal council of Paris has recently authorized an extension of the sewage-irrigation farms, making a total area of over 7,500,000 acres. In Gennevilliers 1,500 acres are irrigated, but this area belongs to farmers and gardeners who pay for the sewage. The owners of another tract covering 1,000 acres are now negotiating with the city for a delivery of sewage. The new farms at Achères will at present consist of 2,000 acres of sterile land which the city of Paris will rent from the State. The city of Mery-sur-Oise owns 1,500 acres, 15 miles from Paris and these are to be at once arranged for the reception of the Paris sewage. Besides the above areas the farmers of Gennevilliers and of Saint-Germain desire to prepare 2,500 acres for the reception of sewage. During the present year, therefore, the irrigated land will amount to perhaps 8,000 acres. It is strange, says our authority, that notwithstanding this demand for sewage by the farmers, there are still persons who cry out against "the poisoning of the atmosphere" about Paris. The amount of sewage created annually is about 12,000,000 cu. m.; the amount which is to be disposed of by irrigation is 1,600 cu. m. per annum per acre. Therefore the above 8,000 acres will suffice for the entire quantity of sewage.

THE city of Berlin is gradually replacing its pavements by asphalt. The first asphalt pavements were laid ten years ago and careful observations as to advantages and disadvantages have been noted. Complaints about its slipperiness have become less and less, showing, evidently, that horses and drivers are getting used to it. It has been found that horses which use both kinds of pavement do not fall oftener on the asphalt than on the stone blocks. The report of the department shows a marked benefit in the wear and tear on the asphalt streets, both regarding vehicles and horses.

DURING the last few years, aerial cable roads have been introduced very widely in Europe. The mining statistics of the German Government for the past three years show that the amount of cable used in the construction of cable roads after the Bleichert patent was by weight one third more than all the wire rope used in the country for other mining purposes. Under this patent, the firm of BLEICHERT & Co. have erected 350 lines, while other builders have constructed many additional lines. Aerial roads in this country are far less common, and are generally limited to single loads of from 75 to 100 lbs. This is accounted for by the fact that they are built when surface roads are impracticable, and then too cheaply to be economical. With us, single ropes are generally, or always, used, while in Europe two ropes are quite commonly employed; a heavy stationary rope supports the load, while a second, lighter rope, serves as a propeller. By means of the double rope system loads of 2,000 lbs. are carried. We agree with the *Engineering and Mining Journal* in thinking it probable that if our engineers would give the matter that attention which it has received abroad the system might be extended in our own country with profit. However Americans are not slow to adopt really good things of this sort, and undoubtedly will improve upon their present use of this system as soon as it appears advantageous to do so.

THE bids have just been closed for the work of depressing the tracks of the New York & Harlem Railroad in the twenty-third and twenty-fourth wards of this city. The total cost of the work will be from $1,250,000 to $1,800,000. This new work is in accordance with the present tendency of practice everywhere and, probably it will not be long before similar work will be inaugurated on the terminals at various other large cities on the Vanderbilt lines.

WE are pleased to record that the tie-up on all the railways of the Northwest, the prospect of which seemed so serious a week ago, has been averted by the removal of the boycott on Chicago, Burlington & Quincy traffic. It is to be hoped that the rumors of further impending strikes on the Burlington system may prove unfounded.

DURING the week landslides have occurred on the Cumberland branch of the Pittsburg, Cincinnati & St. Louis Railway; on the New York, Ontario & Western Railway, wrecking a freight train; on the Fitchburg Railroad near Wayville, N. Y.; a slide also occurred at Vicksburg, Miss. On March 30 the Allentown end of the Castle Shannon railway tunnel under Mt. Washington, Pittsburg, Pa., caved in for a distance of several yards. Washouts have occurred on the Chicago, Milwaukee & St. Paul Railway near Elk Point, Ia. The town of Ninnescah, Kan., was destroyed March 24, by a cyclone.

THE following bridge accidents are reported: An iron bridge at Sheldon, Vt., built by the Berlin Iron Bridge Co., was washed away March 29.——At Brooklyn, N. Y., the bridge over the Gowanus canal at 3rd St., has been damaged by the giving way of one of the abutments.——At Waterville, O., the iron bridge which is being built over the Maumee river gave way, March 30, and fell into the river, owing to the failure of the supports.——In Georgia, 4 county bridges have been washed away in Harris Co.; 2 bridges on the Western & Atlantic Railroad, and 1 on the Georgia Pacific Railway. At Fort Gaines, Ga., a pier of the Chattahoochee wagon bridge was washed out and 1 span fell into the river.——In Michigan it is reported that 60 bridges in Ham Track, Grossy Point and Warrene townships have been washed away.——A broken car wheel on a copper train on the Duluth, South Shore & Atlantic Railway derailed several cars on the Rock River bridge (trestle?), 7 cars fell over onto the ice and the trestle was wrecked.——An engine and several flat cars on the Taylor, Bastrop & Houston Railway went through a small bridge near Bastrop, Tex. Newspaper accounts state that "the cause of the wreck was a dangerous swing in the track of the bridge, which threw the engine off, crushing through the bridge and completely wrecking it. The place had been reported unsafe a number of times."

THE action of the Missouri Pacific in cutting down its dividend rates has been followed by the Atchison, Topeka & Santa Fé, whose directors voted on April 3 to reduce the rate of dividend paid by the company from 7 to 6 per cent. Under the existing status of affairs in the Southwest there can be no doubt that this action is in every way commendable. To hold traffic rates at a point where 7 per cent. dividends or over can be paid is to directly invite the construction of parallel competing roads, for there is an abundance of capital seeking safe investments at much lower rates.

A note from C. E. ALGER, Division Engineer, calls our attention to a slight error in our article in the last issue on the Standard Point Switch of the Boston & Albany Railroad. The rail frogs used are made at the Springfield shops of the company and not at the Ramapo works, as stated.

Proposed Harbor Extension and Docks, at St. John, N. B.

The accompanying cut illustrates the harbor extension and docks at St. John, N. B., as proposed by J. S. ARMSTRONG, M. Can. Soc. C. E. From a paper read by him before the St. John Board of Trade we take the following description of the project:

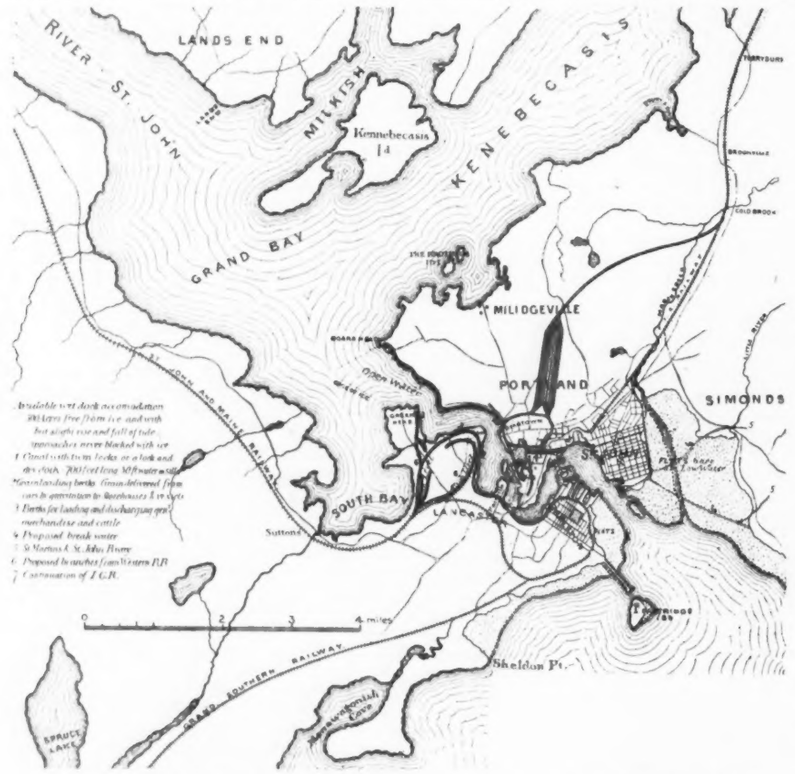
Increasing railroad facilities make possible to St. John a much larger amount of western trade than it has had heretofore. To realize this, greater harbor facilities are necessary. The St. John Canal & Dock Co. propose to increase the harbor facilities by opening up a water area of nearly 1,000 acres which they claim will be in every way adapted to the requirements of the case, and will give 6 miles of shore line, a large part of which will be available for wharfage and dock uses.

The necessity, and something of the feasibility of the scheme, can be understood by a glance at the cut. The water frontage and area opposite St. John, it will be seen, is quite limited. Access is denied to the open water in the river above by the rapids at the point opposite Lancaster. It is here that the cantilever bridge was built two years ago (not shown on the map) almost alongside of the highway suspension bridge, which is now quite an old structure. The narrows in the river at this point are only 400 ft. wide. Moreover, a bend in the river makes the distance to suitable harbor-waters an objection, especially as it can be saved by the proposed canal, from 1,400 or 1,700 ft. long, across the neck of land to the "Cove," and in direct continuation with the present wharves of the city.

The canal involves cutting through a ridge which at its center is from 100 to 150 ft. in height, and composed largely of rock. At the harbor side it is proposed to build twin locks, or two chambers side by side, 600 ft. long by 60 ft. wide, enclosed by heavy side walls, and movable end gates. Both of these locks can be used for passage, but ordinarily one lock will be used for a dry dock.

There are hills so situated in relation to the harbor that lines of railway skirting the harbor can be run around nearly the whole frontage. There will be a system of high and low tracks. From the tracks on a high level grain can pass directly from the cars to the vessels, or grain can be stored on the banks below to be delivered by gravity to the vessels as desired. On the low level tracks general cargo can be handled, there being ample yard room for handling trains, and for storing cargoes, while behind "Mosquito Cove" there is plenty of room for stock yards, or even for pasturage.

The details of the project have not yet been fully completed, the railway arrangements and connections causing some delay, but the company has a very favorable charter, and it is expected that the works will soon be begun.



Proposed Harbor Extension and Docks, St. John, N. B. By J. S. Armstrong, C. E.

Efflorescence and Impervious Mortar.

BY IRA O. BAKER, PROF. C. E. UNIV. ILL.

Plastering and masonry, particularly in a moist climate or in damp places, as cellar walls, is frequently disfigured by the formation of a white efflorescence on the surface; the deposit generally originates with the mortar, but frequently spreads over the entire face of the wall. It is caused by the water which is absorbed by the mortar dissolving the salts of soda, potash, magnesia, etc., contained in the lime or cement, which on evaporating deposits these salts as a white efflorescence on the surface. With lime mortar the deposit is frequently very heavy, particularly on plastering; usually it is heavier with Rosendale than with Portland cement. The efflorescence sometimes originates in the brick, particularly if the bricks are burned with sulphurous coal, or are made from clay containing iron pyrites; when the brick gets wet, the water dissolves the sulphate of lime and magnesia, and on evaporating leaves the crystals of these salts on the surface. Frequently the efflorescence on the brick is due to the absorption by the brick of the impregnated water from the mortar.

This efflorescence is objectionable because of the unsightly appearance which it often produces, and also because the crystallization of these salts within the pores of the mortar and also of the brick or stone, causes disintegration in many respects like frost.

As a preventative, GILLMORE recommends* the "addition of 100 lbs. of quick lime and 8 to 12 lbs. of any cheap animal fat to each barrel of cement." The lime is simply a vehicle for the fat, which should be thoroughly incorporated with the lime before slacking. The object of the fat is to saponify the alkaline salts. The method is not entirely satisfactory, since the deposit is only made less prominent and less effective, and not entirely removed or prevented, and farther the grease and lime both retard the setting and also weaken the mortar.

It would be better to prevent the efflorescence by rendering the mortar non-absorbent. This may be accomplished by using the principle of the well known "Sylvester's Method of Repelling Moisture from Walls." This process consists in using two washes or solutions for covering the surface of the wall; one composed of Castile soap (any potash soap is equally good) and water, and another of alum and water. The proportions usually employed are: three-quarters of a pound of soap to one gallon of water, and half a pound of alum to four gallons of water, both substances to be perfectly dissolved before being used. The soap-wash is laid on hot, and well rubbed in; after it has become thoroughly dry, the alum wash is applied in the same manner. These washes may be applied as many times as is thought necessary. Four coatings of each wash rendered the brick walls of the old Croton reservoir practically impenetrable to water under 40 ft. head. The cost was 10 cts. per sq. ft.

Instead of applying the washes externally after the wall is completed, it is better to mix the ingredients directly in the mortar. For this purpose 1 per cent. of alum and an equal amount of common soft soap is about right; the alum is powdered and added to the dry cement and sand, and the soap is dissolved in the water used in making the mortar. This method is applicable to masonry composed of impervious stone or brick, and particularly for pointing mortar or for the mortar in the outside of joints. It is also specially suited for plastering for cellar-walls and floors. The principle is that compounds of alumina with the fatty acids are formed in the mass of the mortar by the double decomposition of alum and a potash soap. These compounds are insoluble in water, are not acted upon by the carbonic acid of the air, and add considerably to the early strength of the mortar, and somewhat to its ultimate strength. However, the principal advantage is that the formation of the insoluble compounds of alum and soap decreases the power of absorbing water. All mortars absorb water freely; the best cement mortars, either neat or with sand, absorb 40 to 60 per cent. of their weight. Consequently mortar disintegrates rapidly under the action of frost and also by the crystallization of the salts which form the efflorescence.

This use of alum and soap in mortar was suggested to the writer by a knowledge of the peculiar feature of the "Advance" artificial stone, the process for making which is patented by WM. M. MCMURTRIE, E. M., Ph. D., Professor of Chemistry, University of Illinois, Champaign. It is not shown that alum and soap have ever been thus used in mortar for masonry, but there can be no doubt of its success for the above artificial stone was used considerably in Washington, D. C., 10 or 12 years ago, for example, for the trimmings of the National Museum, for store-fronts and for window caps, etc., for several dwellings, and is reported to have been free from efflorescence and also to have stood the weather excellently. The artificial stone made by using alum and soap has an absorption power of about twice that of granite, about equal to the best lime-stone, and about one-tenth or less of that of the best sand-stones.† The evidence would, at least, seem to warrant a trial; it could be easily tested in the case of pointing mortar.

*Limes, Hydraulic Cements and Mortars, p. 296.

A Proposed New Water Supply for Paris.

Herr RITTER, a Swiss engineer, has submitted a plan to the Municipality of Paris for an inexhaustible and ample supply of water. The source is the lake of Neufchâtel, Switzerland, and the cost is estimated by this engineer at about $58,000,000. A scheme to take a supply from Lake Geneva at a cost of nearly $100,000,000 was proposed some time ago by M. BEAU DE ROEHAS, but probably on account of its great expense Paris did not accept it. Herr RITTER is an engineer who has established a reputation for the construction of water-works, and the success attending the works he erected at La Chaux-de-fonds

† H. A. Cutting, State Geologist of Vermont, in Van Nostrand's Eng. Mag., Vol. 24, pp. 393-5.

has encouraged him to make the proposal in question to the Paris Municipality.

The length of Herr RITTER'S proposed route from the lake of Neufchâtel to Paris is 312 miles, and the surface of the lake is 1,620 ft. above the mean level of Paris. The total area of the lake is some 87,000 acres, and with an allowance of 132 galls. for each inhabitant of Paris there would be no appreciable lowering of the water in the lake.

The intake pipe at the lake will be 262 ft. below the surface, where the temperature of the water is 43° F., and it is claimed that the water can be delivered in Paris at a temperature of 50°. The water will first be conveyed through a tunnel 22 miles long, under the Jura mountains to the Dessoubre valley, in the Department of the Doubs, and thence in an arched conduit along the slopes of the hills to Paris, where it would arrive at an elevation of 394 ft., or with 99 ft. more head than the present supply. This head of 394 ft., combined with a flow of 4,400 galls. per second, would give a tremendous motive power. Herr RITTER has calculated that in this manner Paris could be furnished not only with an illimitable supply of excellent drinking water, but also with power for electric lights in all the streets, and water-power in all the workshops at a reasonable price. In addition to this there are to be considered the advantages accruing to the districts through which the conduit would be laid, which could also draw their supplies from the same source. Herr RITTER estimates that it would take six years to complete the works along the whole line.

Train Lighting by Electricity: Burlington, Cedar Rapids & Northern Ry.

We are indebted to the courtesy of Messrs. J WHITE, Superintendent Water Supply office, and WM. VOSS, Assistant Master Mechanic of the Burlington, Cedar Rapids & Northern Railway, for particulars of the system of train lighting recently introduced upon that line. Two trains have been equipped with the system, not for advertising purposes, but to ascertain the economy and practicability of the electric light in actual daily service on the road.

The trains each consist of one mail and express car, one baggage car, one smoking car, one ladies car and one sleeping car and are run between Burlington, Ia., and Albert Lea, Minn., a distance of 253 miles. Of these cars, the baggage, smoking and ladies cars only are lighted, the mail and sleeping cars, not laying over at these trip terminal points.

The trains were put in service on March 10, and have thus far not given the least trouble, requiring no attention while on the road and nothing except recharging of the batteries when laying over at Albert Lea. A storage battery of 24 cells, made by the New York Electrical Accumulator Co., is placed on the floor in one corner of the baggage car. This supplies 24 ten-candle power, 50 volt incandescent lamps, distributed through the three cars, for a time of 12 hours, or a little more than is required for the round trip.

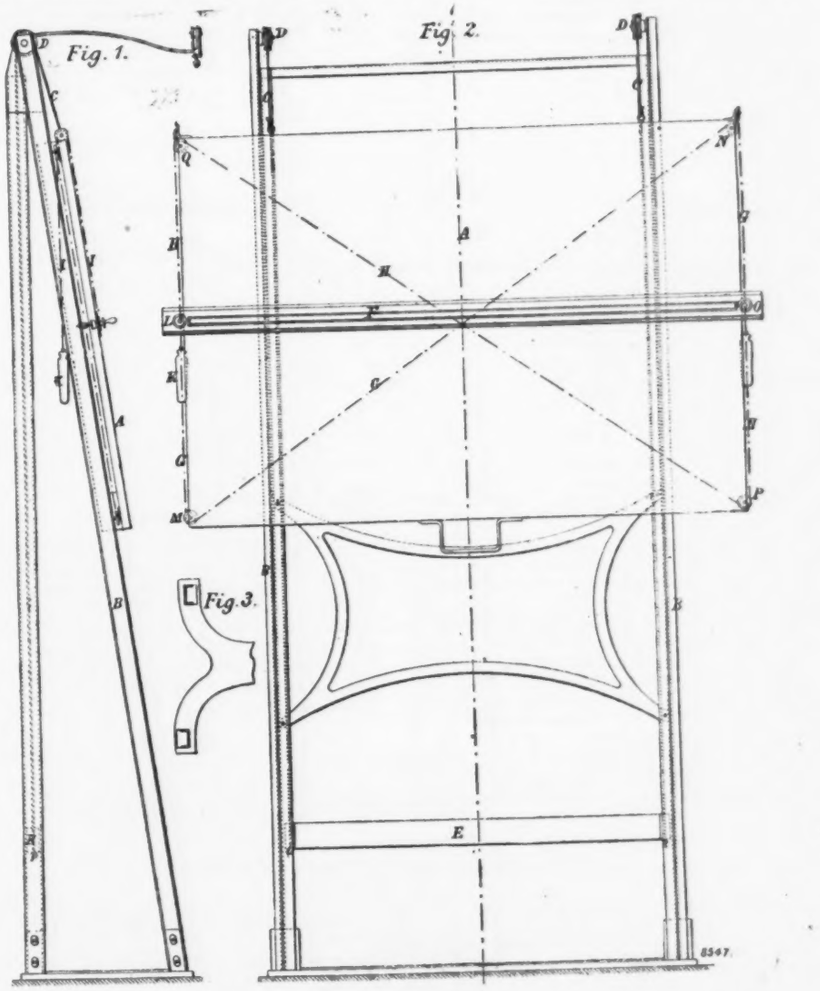
The recharging of the battery at Albert Lea requires from 5 to 7 hours, and as the train lies there for about 20 hours, this is accomplished without removing the battery from the car. For recharging the batteries a 30 light U. S. dynamo, requiring about 2½ H. P., is used. It is run by a belt from the line shaft in the machine shop at the round house, and a No. 6 covered wire carries the current to the car, a distance of 200 ft.

The short time the system has been in use makes it impossible to give any accurate figures of the cost of plant and maintenance; but as one of the principal objects in establishing this system was to ascertain these data, such estimates will doubtless be made at an early date.

These same trains have been fitted with pipes for heating the cars direct from the engine. The system of piping and the hose coupling have been designed at the company's shops, and the same drip has been adopted that is in use by Mr. EMERSON on the Connecticut River Railway; that is, a common ¾-in. angle valve with a $\frac{1}{32}$-in. hole drilled through the seat to allow the condensation to escape. President IVES is so well satisfied with this system that he has ordered it on all cars passing through the shop. The apparatus has been in service since Dec. 1st on about 10 cars. The cost is $70 per car.

A Vertical Drawing Board.

A late number of *Engineering* gives a description and illustration of a new vertical arrangement of a drawing board as used in the engineering works of Herr J. M. VORTH, at Heidenheim, Wurtemberg. The draughtsmen are said to prefer it to the horizontal plan for purposes of convenience and health. The description given by our contemporary is as follows: The drawing board itself *A*, is caused to rest against two ⌐ iron supports *B B*, which incline from the vertical about 1¾-in. in the foot. The board is capable of sliding up and down the bars *B B*, being carried by two ropes *C C*, which go over the pulleys *D D*, and to the other ends of these ropes is attached the counterbalance weight *E*, which is sufficient to support the weight of the board, straight edge *F*, set squares, etc.



A Vertical Drawing Board.

The straight edge *F* serves the same purpose as the ordinary T square, and is made to travel from top to bottom of the board perfectly parallel, by means of the cords *G G* and *H H*. The weight of this straight-edge, etc., is taken by two cords *I I*, and counterbalance weights *K K*. The parallelism of the straight-edge is effected thus: One end of the cord G G, which is attached to the straight edge at *L*, passes over the two pulleys *M N*, and the other end is attached to it at *O*. The cord *H H* is attached to the straight-edge at *O*, then passes over the two pulleys *P Q*, and the other end is fastened to it at *L*. Means are provided at *L* and *O* for taking up the slack in these two cords.

This vertical arrangement presents certain advantages over the ordinary horizontal drawing board and T square, particularly when the work required is very large, as it avoids stooping or leaning over the board.

Bernardo's Method of Electric Welding.

According to a quite full description of this new process which appears in the *Electrician*, it appears to be one of no little merit and promise, the principal difference between BERNARDO'S method and those of SIEMENS, WALLNER, COWLES and others of his predecessors lying in his making the metal to be welded the negative pole, while the carbon is the positive pole. This keeps the metal clean and unoxidized. The electricity for the current is supplied from storage batteries. A large number of cells, having been stored, few or many may be used according as the particular welding process requires. The cells being in readiness, one end is joined to the metals to be welded while the other is connected by means of a flexible lead to a carbon rod in a portable holder. By touching the carbon to the metal and immediately withdrawing it from ¼ to ⅛ in. an arc is struck, and the metal at this point immediately melts. A great advantage of this method over the ordinary process of welding, is that the heat can be brought to the metal, instead of the reverse, so that welding on a boiler can be done with the boiler in place. The process has been used to join all the ordinary metals, to weld copper and brass, to coat iron with copper, tin and lead, and even to cut a piece of iron plate, the melted metal running off like water, if not retained. Altogether the process seems likely to prove of considerable practical value.

A FUND is being raised in Holland to defray the expenses of a survey of the Zuyder Zee with a view to its drainage. This sea was formed in 1282 by the breaking of land barriers and engulfed 72 villages. It is proposed to dam the entrances, and pump out the present sea, leaving a small lake connected by a canal with Amsterdam.

Recent Researches in Friction.*

(*Continued from page 241*)

In the first part of the paper, of which the present communication is a continuation, the author brought forward many points on the theory of sliding friction, as ascertained by recent experiments; and from them he deduced several laws which appear to hold in a broad and general sense. He has since made a large number of experiments in the Engineering Laboratory of University College, London, to find what relation exists between the total frictional resistance of a brass and the chord of its arc in contact with the journal. On account of the limited motive-power at the author's disposal, the size of the journal, and the total load carried by it, were necessarily small.

The wear on the brass during these experiments has been carefully noted, and the results throw much light on the obscurity which has hitherto surrounded this point.

FIG. 1.

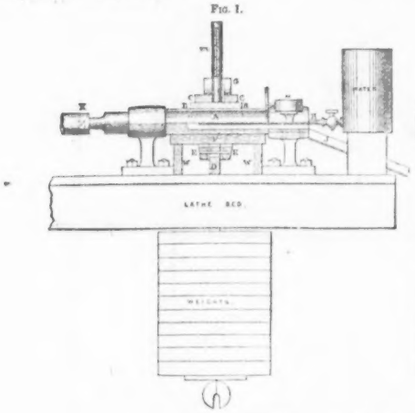
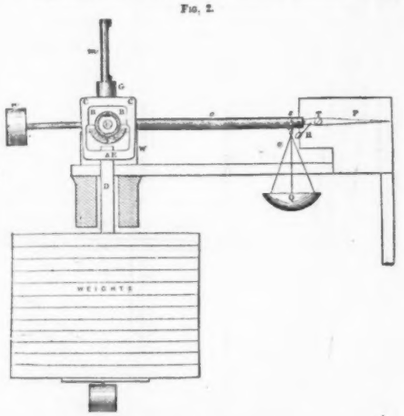


FIG. 2.



Goodman (Modification of Tower) Friction Testing Apparatus.

Speed experiments have been made under various conditions of load and temperature, the much disputed question of whether the frictional resistance rises or falls with low speeds has been fully investigated, and the conditions necessary for either case have been determined.

Some experiments on brasses, when sliding transversely on a revolving shaft at various speeds, show that it is possible to reduce the transverse coefficient of friction to an infinitesimal amount by increasing the circumferential, and decreasing the transverse, velocity.

Heavy machinery always requires much more power to start its motion when oil is used as a lubricant than when a heavy solid grease is employed, although the coefficient of friction of the former is considerably less than that of the latter; the author has investigated this matter, and thinks he can reasonably account for the apparent anomaly.

The author gives a few practical hints on the design of oil and friction testing apparatus, and has pointed out the errors liable to occur in experimenting, which can only be eliminated by great care and attention.

The latter part of this paper is devoted to the friction of ball bearings, showing the influence of load and temperature upon them, also their relative value when compared with plain bearings.

DESCRIPTION OF APPARATUS.

The apparatus used by the author was made by him specially for these experiments. It is a modification of the machine employed by Mr. TOWER in his experiments on friction. In Figs. 1 and 2, *A* is the journal on which the frictional resistance of the brass *B* was measured; it was tightly fitted into the cast-iron strap *C*, and the weights were suspended from it by the link *D*, which rests on the knife-edge *E*. The oil-bath *F* is filled with oil, into which the bottom of the journal dips; it is shown in detail in Fig. 6. A siphon lubricator *G* is provided for siphon experiments; the temperature of the journal is kept constant by using the circulating water-pipe *H*, the waste from which is carried away by the pipe *J*; the shaft is driven by the lathe-chuck *K*, the revolutions of which are registered by the counter *L*. The temperature of the brass is registered by the thermometer *M*. The arm *O* carries the scale-pan *Q*, which is suspended from the knife-edge *S*, the whole of which is counterbalanced by the weight *N*. The pointer *P* indicates when the arm is horizontal, the long arm of which is balanced by the small weight *R*.

FIG. 7.

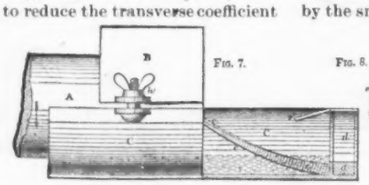


FIG. 8.

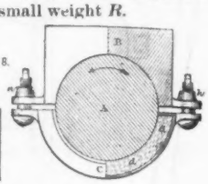
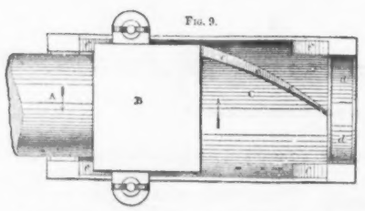


FIG. 9.



Apparatus for Securing Bath Lubrication with Ordinary Journals.

METHOD OF EXPERIMENTING.

The shaft on which the experiments were made was of manganese steel 2 ins. in diameter.

The bearing, composed of an alloy of 1 part of tin to 7 parts of copper, was 4 ins. long, while its width varied from 2 ins. to ¼ in. Bell's asbestos lubricating oil (sp. gr. 0.915) was used throughout for all the experiments. Various methods of lubrication were adopted. These included: (1) "perfect or bath lubrication," in which the journal dipped in oil; (2) "saturated pad," in which a pad, standing in oil, was placed so that its upper part pressed on the bottom of the shaft, and which represents the maximum efficiency of pad lubrication; (3) "ordinary pad," where a pad was used with a very meagre supply of oil, namely, 0.02 lb. of oil on 0.05 lb. of pad. This was found by experiment to be the smallest quantity consistent with safety, and represents the minimum efficiency of pad lubrication, the pad used in general practice coming between these limits; (4) the "siphon" lubricator of the ordinary type, provided with lamp-cotton, to feed three drops of oil per minute.

Before commencing the experiments the machine was run for about three days, in order to wear the brass down to a good bearing-surface, after which the whole of the framework was balanced, as subsequently explained.

The machine was driven by a ⅛ H. P. Davey motor, which is peculiarly adapted for small-power experimental purposes, as its speed can be easily regulated within a range of from about 60 to 300 revolutions per minute; at the higher speeds the engine developed far more than its nominal H.P., so that steam had to be supplied from a larger boiler. When very slow speeds were required the back gear of the lathe was used.

After the engine had been adjusted to the required speed, the temperature of the journal was regulated by heating the surrounding air with a Bunsen gas-burner, or by circulating water through the center of the shaft; then, after running from ten to fifteen minutes, the machine was balanced by putting weights in the scale-pan Q, which brought the arm *O* to a horizontal position. When thus balanced it was allowed to run for five minutes, during which time the brass was occasionally given a lateral motion of about ¼ in. by hand, to ensure that everything was in a normal condition; this process was repeated every time the load was altered, the alteration of load being 50 lbs. at a time. Readings were taken in every case both with increasing and with decreasing loads; and if any irregularity occurred, two or more sets of readings were taken, and their mean are the readings given. At every second or third reading the speed of the engine was checked by the counter.

The coefficient of friction was found thus from the weight in the scale-pan *Q*. The diameter of the shaft is 2 ins., therefore the radius at which the frictional resistance acts is 1 in. The length of the scale-pan arm *O* from the center of the shaft to the knife-edge *S* is 21 ins., therefore a weight in the scale-pan acts at a leverage of 21 to 1.

Let x = the weight in lbs. in the scale-pan.
W = the total load on the brass in lbs.
Then $21 \times x$ = the frictional resistance (total).
and $\frac{21 \times x}{W} = \eta$ = the coefficient of friction.

After a complete set of experiments had been made with a semi-circular brass, the sides were cut away to reduce the chord in contact, and another set of experiments was carried out as before.

The mean results of all these experiments are given graphically by the curves on Figs. 1 to 7. The frictional resistance curves gradually become more nearly horizontal as the brass is cut away at the sides, which shows that the lubrication is more perfect with a narrow brass, probably because the sides of the brass when almost semi-circular prevent the lubricant from getting to the crown and the off-side of the brass. When the lubrication is perfect, the frictional-resistance curve becomes a horizontal straight line, and the coefficient-of-friction curve becomes a hyperbola.

NOTES ON FRICTION AND OIL-TESTING APPARATUS.

The author, having constructed and used two of the most general forms of dead-load frictional-testing machines, thinks that a few notes on their design, arrangement, and peculiarities of working, may be of some practical value to other laborers in the same direction. Many of the details that must be attended to, in order to ensure success, are of a rather obscure nature, and are frequently not detected until a great deal of time and labor has been wasted. The two machines referred to are (1), the form adopted by Mr. STROUDLEY, M. Inst. C. E.,[1] and (2), that adopted by Mr. TOWER.[2] Each of these has its own special advantages and disadvantages. The first, when accurately constructed, runs rather more steadily than the latter, consequently there is less liability to error in taking readings; also the lubricating arrangements are easily accessible, as the bottom of the shaft is open; this can hardly be

* A paper read at a Student's Meeting of the Institution of Civil Engineers, by John Goodman. Trans. Inst. C. E., 1887, Stud. (now Assoc. M.) Inst. C. E.

[1] Minutes of Proceedings Inst. C. E. vol. lxxxv. p. 379.
[2] *Ibid.*, vol. lxxxv. p. 378.

said of the "Tower" machine, in which the weights are suspended from a central stirrup, which leaves very little space for the baths, pads, etc. Then, again, the loads in the first machine are more accessible, from their being quite free from the framing of the machine, which is very important, as the separate weights are often of considerable size, sometimes 2½ cwt. each. But, on the other hand, there is a disadvantage in No. 1, in that the most scrupulous accuracy is required in making the separate weights exactly equal, and the weight-beam and links must be exactly balanced. The balancing of the weights and beam is effected thus:—after the beam has been machined very accurately, so that the jaws in which the brass fits are central with the knife-edges on which the weights hang, a temporary knife-edge is fitted in the center of the jaws, and the beam itself balanced upon it. The weight-links are hung on and also balanced; then this knife-edge is removed, and the brass having been fitted in, it is

FIG. 11.

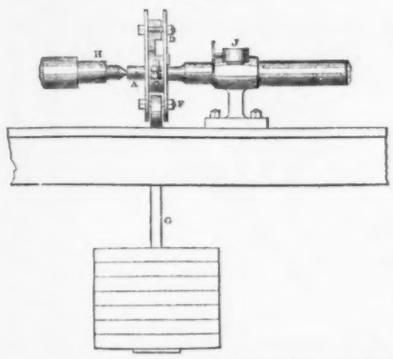
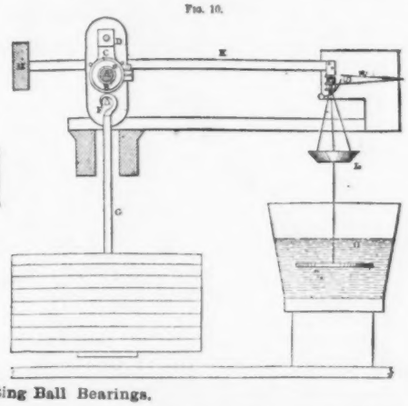


FIG. 10.



Apparatus for Testing Ball Bearings.

placed on a short turned mandrel which exactly fits it. The whole is now placed on a smooth and level plane, and the beam again balanced by altering the brass in the jaws until the center of the mandrel is central with the knife-edges; by this means a practically frictionless vibrating motion is obtained; the weights themselves are placed on the links, and each pair is balanced and marked.

After the machine has been running for some time its balance is disturbed, unless the brass is frequently reversed to keep the wear central. This matter of the inequality of the wear will be fully treated under the head of the "wear of brasses."

FIG. 12.

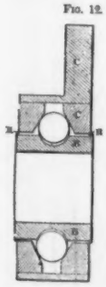
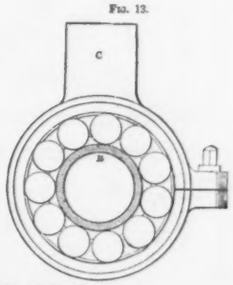


FIG. 13.



Rudge Ball Bearing.

The inequality of the wear is occasionally very rapid under heavy loads, a few days' hard running will cause the brass to wear about 0.01 inch out of the center. Suppose the load on each link to be ¼ ton = 1,120 lbs., then with one arm of the beam lengthened 0.01 inch, and the other shortened 0.01 inch, there will be 1,120 lbs. acting at the end of a lever 0.02inch long, which, with an equivalent weight-arm 72 ins. long, gives an error of $\frac{0.02 \times 1,120}{72} = 0.311$ lb. in the scale-pan; this with a 7-inch shaft becomes an error of 0.0028 in the coefficient of friction, being in some cases more than 100 per cent. Thus a very small error in construction or unequal wear produces an enormous error in the results.

The beams of these machines must be much stronger than an ordinary beam to carry the same load, for the sake of stiffness; if not, a great deal of vibration is set up when running. The brasses, also, should be very heavy and stiff, or else enclosed in a strong outer casing; otherwise, they invariably open at the sides when the load comes on. The journal on which the experiments are made should be of larger diameter than the rest of the shaft, to prevent deflection in it when fully loaded; overhung journals should never be employed under any considerations.

The second machine is easily constructed, and the weights themselves do not require any very accurate adjustment, as any error in them simply alters the dead load on the bearing, which is of no consequence if the error be known.

In the construction of these machines the main point to be attended to is the proper balancing of the scale-pan arm, and to ensure that the knife-edge *E*, Figs. 1 and 2, the center of the shaft *A*, and the scale-pan knife-edge *S*, are the three angular points of a right-angled triangle; then when the two latter points are on a horizontal straight line, the two former are in a vertical line. As the slightest error in the position of any of these points will lead to a large error in the results, the most convenient method of proving the accuracy of the machine is to mount it on a mandrel, as described above, and to mark the position of the pointer *P* before loading. When loaded it should retain its original position; but if there be any error of construction the pointer will occupy a new position, and the knife-edges and balance-weight must be adjusted until the above condition is fulfilled. This machine also is liable to be thrown out of balance by the unequal wear of the brass; the error is of exactly the same magnitude as in No. 1 machine, taking the same dimensions as before.

Let r = radius of the journal = 3½ ins.;
s = the horizontal distance of the knife-edge from the vertical through the center of the shaft = 0.01 in;

then $q = \frac{s}{r} = \frac{0.01}{3.5} = 0.0028$, which is the error due to the unequal wear of the brass. There will also be a slight error due to the alterations of the length of the scale-pan arm, but this is negligible.

In designing one of these machines, the knife-edge *E* (Figs. 1 and 2) must be kept as near the center of the shaft as possible, as the further they are apart the less sensitive is the machine; the length of the arm *O* should be from six to eight times the distance of *E* from the center of *A*.

VIBRATION.

Vibration often causes a great deal of trouble in friction machines; it can generally be prevented by tightening the pointer-screw *T* (Fig. 2) just sufficiently to steady the arm, but not tightly enough to prevent its coming to a normal position; a dash-pot was used on the ball-bearing machine, details of which are given under that heading.

TEMPERATURE.

In making experiments to determine the influence which temperature has on the friction, great care must be taken to arrange the bulb of the thermometer as near the surface of the journal as possible; better results will be obtained if the bulb be surrounded with mercury.

BATH LUBRICATION.

The objection is often raised that bath lubrication is only obtainable in special cases of scientific experiments, and that therefore it is of little or no practical value. The great advantages arising from this system of lubrication are, however, undoubted, and the author has therefore designed a bath suitable for use with many forms of ordinary journals, and has found it to answer satisfactorily. The arrangement is shown in Figs. 7, 8, and 9, where *A* is the shaft carrying the brass *B*, to which the bath C is attached by the screws *h h*; the oil is prevented from leaking out at the ends by leather packing *d*. When running at high speeds, the oil is carried round by the shaft, and flies about in all directions; to prevent this a "baffler" strip *e e* is arranged slanting towards the center, and approaches the shaft within about $\frac{1}{32}$ in. Rings of oil form on the journal at each end of the bath, even at moderate velocities, which if not prevented will cause a great waste of oil. These are skimmed off by lips at each corner *f f*. When properly fitted this bath will answer perfectly at 400 revolutions per minute. The author has not had an opportunity of trying it at a higher velocity, but believes it would be equally efficient at 1,000 revolutions. It can be made of cast-iron, brass, or sheet metal. For friction experiments it must not be attached to the brass, as it would greatly increase the friction upon it. In Figs. 1 and 2 it is made with flat ends, and wedged up tightly with wooden wedges *W W*.

RELATIVE VALUES OF DIFFERENT SYSTEMS OF LUBRICATION.

In estimating the value of any system of lubrication, the quantity of oil consumed must be considered as well as the reduction of friction. Bath lubrication is very effectual in reducing frictional resistance, but it uses a rather larger quantity of oil than the other systems. Pad lubrication, especially when a saturated pad is employed, is almost as efficient in reducing friction as the bath, and consumes a much smaller quantity of oil (Appendix, Table VII). Siphon lubrication, and all methods of applying oil to journals by drops is extremely wasteful and inefficient in reducing the friction, as the oil runs away long before its lubricating properties are exhausted. If the oil be tested after having passed through a bearing, it will be found to possess lubricating qualities almost as good as it had originally; when a pad is used, this oil is used over and over again till thoroughly worn out. Pads in continuous use need renewal every three or four months with thick vegetable oils; but if a thin mineral oil be employed they will run for two or three years without renewal.

There would be very few hot journals if the bearings were properly designed with pad lubricators. The author has permanently cured obstinate cases of hot bearings by cutting away the sides of the brasses, and inserting a tightly braided strip of lamp-cotton at the sides, leaving the siphon on as before, and only applying about one-quarter the quantity of oil previously used.

BALL BEARINGS.

The experiments on ball bearings were carried out on an ordinary "Rudge" bicycle bearing.

The apparatus for measuring the friction upon it is shown in Figs. 10 and 11; the bearing contained eleven $\frac{5}{16}$-in. balls, and was mounted on a frame. The spindle *A*, ¾ in. in diameter, was fitted with a hardened steel sleeve *B*, in which a groove was turned to keep the balls in position. *C* is the case of the bearing, which is clamped in the frame *D* by bolts, the lower one of which, *F*, formed the knife-edge for suspending the weight link *G*. The spindle was supported at its outer end by the lathe head-stock *H*. The revolutions were indicated by the counter *J*. The arm *K* with its scale-pan *L* was balanced by the weight *M*, the pointer *N* indicated when the arm was horizontal. *O* is a dashpot for preventing vibration of the arm. The diameter of the sleeve *B* is 1 inch. The diameter at the bottom of the groove is 0.875 in. The mean diameter at which the balls bear is 0.978 in. They do not touch the bottom of the groove. The radius at which the frictional resistance acts is 0.489 in. The length of the arm *K* is 14.69 ins.; therefore the leverage of the machine is $\frac{14.69}{0.489} = 30$ to 1. Then if x = the weight in the scale pan in lbs., the total frictional resistance is 30 x, and the coefficient of friction is $q = \frac{30\,x}{W}$, where W is the total load on the bearing in lbs.

The method of experimenting was the same as that described for plain bearings, the lubrication however was not continuous; the bearing was thoroughly oiled before each experiment. Great difficulty was experienced at first with the excessive vibration due to each ball as it passed over the top of the bearing, slightly raising the whole frame and load, and then immediately allowing it to drop; but this was effectually overcome by fastening by a fine wire to the bottom of the scale pan a thin leaden disk which was placed in a bucket of water.

It is a matter of great importance to have the bearing adjusted neither too tight nor too slack. In the former condition the case C bears on the central sleeve B at RR (Figs. 12 and 13) instead of being supported by the balls; this occurs more frequently with heavy than with light loads, and hence the bearing must be adjusted to suit the load it has to carry.

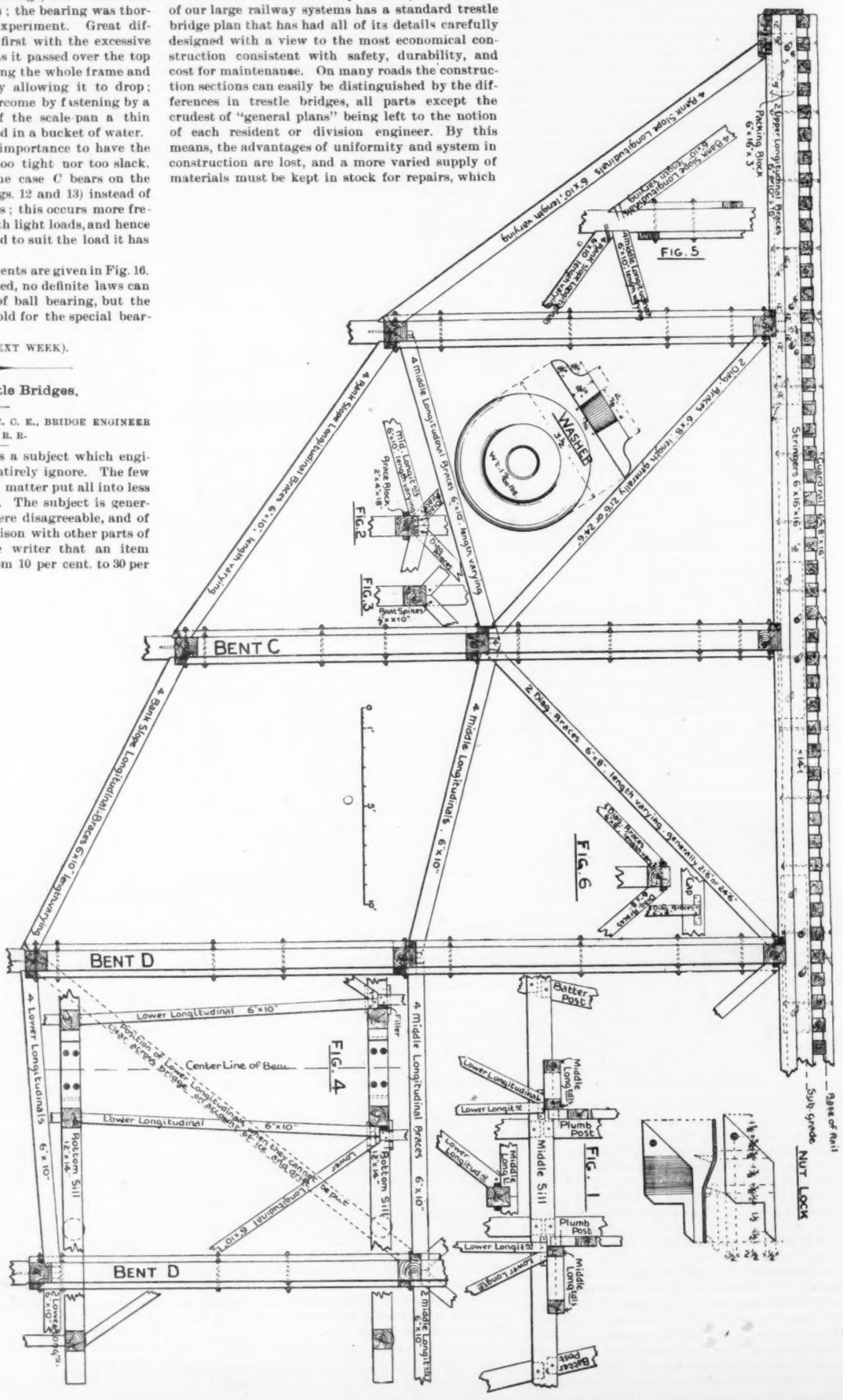
The results of the experiments are given in Fig. 16. As they are somewhat limited, no definite laws can be deduced for every form of ball bearing, but the following laws appear to hold for the special bearing used:—

(CONCLUDED NEXT WEEK).

Pile and Trestle Bridges.

BY A. F. ROBINSON, M. AM. SOC. C. E., BRIDGE ENGINEER C. B. & N. R. R.

Pile and trestle bridging is a subject which engineering text-books almost entirely ignore. The few writers who do speak on the matter put all into less than a page of ordinary size. The subject is generally treated as though it were disagreeable, and of little importance in comparison with other parts of roadway. It seems to the writer that an item which is liable to reach from 10 per cent. to 30 per cent. of the total cost of road to sub-grade is well worth the most careful study. Hardly a single one of our large railway systems has a standard trestle bridge plan that has had all of its details carefully designed with a view to the most economical construction consistent with safety, durability, and cost for maintenance. On many roads the construction sections can easily be distinguished by the differences in trestle bridges, all parts except the crudest of "general plans" being left to the notion of each resident or division engineer. By this means, the advantages of uniformity and system in construction are lost, and a more varied supply of materials must be kept in stock for repairs, which



Standard Wooden Trestles: Chicago, Burlington & Northern Railroad.

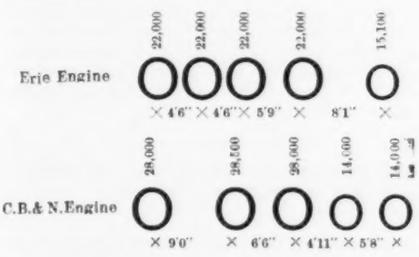
A. F. ROBINSON, Bridge Engineer.

Charles Latimer

increases the cost and also the chances for mistakes in forwarding supplies. On some roads this work is given to the younger engineers, who have had little or no experience in construction, and who know nothing about ways of contractors or of mill men in working lumber.

In submitting these plans to the engineering public, the writer is aware that Mr. WELLINGTON, in his work on Railway Location, advises the use of split stringers, sill and caps, and the avoidance of all mortises. This is undoubtedly the better plan so far as stringers are concerned. It is also best for tall trestles (say over 45 ft. high); but for structures of ordinary heights, I am not satisfied with results obtained from trying to use split caps, sills and posts. As yet, I have found no satisfactory and economical method for avoiding mortises in the connection of caps and sills with posts.

The aim in making plans was to obtain perfectly safe structures at the lowest cost compatible with durability and economy for maintenance. The rolling loads used are the Erie Consolidation engine and the C. B. & N. Class "B" engine. (See diagrams of wheel loads.)



Under the above rolling loads, track stringers are strained 1458 lbs. and 1194 lbs. respectively per square inch on extreme fibres. Under the ordinary eight-wheel engines, stringers are strained 963 lbs. per square inch on extreme fibre. The class "B" is the heaviest engine used regularly on the line. In calculating strains no account is taken of partial continuity caused by method of packing stringers at caps.

All timber, except ties, should be of soft pine, free from shakes, wanes, black and unsound knots, and all description of decay. Stringer timber should be of the grade usually known as No. 1 common. The ties should be of white oak, 8 × 8 ins. × 10 ft. and surfaced on one side so that they shall be 7¾ × 8 ins. No variation should be allowed in the 7¾ in. dimension. Piles should be of good sound white oak, entirely free from bark, not less than 10 ins. in diameter at the smaller end and 14 ins at the larger end. If desired by the engineer in charge, the piles should be driven until a 2,000 lb. hammer, falling 20 ft. will not sink the pile more than one inch.

The decks of these bridges are designed with the understanding that some effective re-railing device (presumably Latimer's) is to be used. Cars very rarely jump the track while crossing a bridge; the accident usually happens just before reaching the bridge; for this reason, no inside guard rails are used, the outer guard rails being sufficient to guide a derailed truck safely across the bridge. In this manner we do away with long ties and side stringers, and obtain a floor in which no part of the stringer is seriously overloaded in case of derailment. All details of construction are shown in the accompanying drawings.

The advantages claimed for this method of arranging stringers are:

1st. The use of single length pieces only (i.e., 16 ft.)

2nd. All longitudinal slipping of the deck is prevented, and the bents are held in position in case of a wreck.

3rd. Short or sharp kinks in alignment, due to the unequal settlement of the piles, are not apt to occur. Lining is done by jacking the deck over on the caps.

4th. The track rails will always be symmetrically placed over stringers, and ties will only have one set of spike holes.

5th. No sub-stringers are needed, and there is no need for cutting shoulders into lower edge of stringer.

Very few engineers realize the importance of longitudinal bracing in tall trestles, and how much the want of the same has to do with the wearing qualities of the ordinary trestles, under traffic. Several tall trestles have fallen the past year before being finished, on account of insufficient longitudinal bracing.

I have tried to avoid the use of timber in other than regular mill sizes and lengths: also, the heights of trestle bents are so taken as to use nothing but even lengths, with very little cutting. The use of extra long timber, i. e., longer than an ordinary car, has been avoided as far as possible. Material bills are so arranged as to reduce to a minimum the work of making accurate preliminary estimates. They can also be used for making the regular monthly estimates of work done.

The "bank slope longitudinals" will generally be covered with grade material, and as a result, will rot out in a few years, but they will last until the banks have finished settling and slipping. In the two-story plan, the first bent is shown too high for the slope of the banks. This was to show first bent for exceptional cases, and to allow the next bent to be of maximum height.

After the deck material has become thoroughly seasoned, the guard rail bolts should be carefully tightened and the holes in tops of guard rails filled with coal tar or pitch.

In the "Box Culverts" the number of different sized pieces was reduced to a minimum, and they are made of proper sizes to allow for putting in one or two cast-iron pipes later.

The box culverts were not designed by the writer, but are included to fill out the set of plans.

In addition to the details touched on by Mr. ROBINSON, the following notes, as to the engravings herewith and certain details not given on them, will be of value:

Fig. 1 shows the manner of fastening the lower and middle longitudinals to the middle sill when the lower longitudinals do not extend clear across the bridge. Fig. 2 shows the connections of diagonal braces and middle longitudinals at foot of plumb posts on middle sill. Fig. 3 shows the same as Fig. 2, without longitudinals. Fig. 4 represents the manner of putting in the last panel of lower longitudinals. These have 4 pieces. In Fig. 5 a plan is shown for use when one pile-bent is used. The manner of fastening diagonal braces to caps is shown in Fig. 6. For this there is required: one brace block 2 × 4 ins. × 1 ft. 6 ins., 6 40-d. spikes, 2 square boat spikes ½ in. × 10 in. Before the block is put in place, two 40-d. spikes must be driven through the block and into the brace from the back side.

Unless otherwise noted in the bills of timber, soft pine only is used. The ties are all laid one way with hearts up or down. In all spans of more than 16 ft., the ties are to be placed 14 ins. between centres. They shall be ordered 8 × 8 ins. × 10 ft. and sized to exactly 7¾ × 8 ins., as above stated. They must be so spaced that the guard rail bolts will always miss the caps. If this cannot be done otherwise, bolt through second instead of through third tie. Splices in the guard rail must always be over a tie. The cut of splices is 8 ins., as shown in the elevation; at each splice 2 square boat spikes, ⅝ ins. × 10 ins. are used. In all bridges the first and last guard rail bolts are not more than 18 ins. from end of span. For each nut of guard rail bolts a 2 in. hole ⅝ in. deep is bored into the guard rail, and nut of guard rail drawn down until its upper surface is flush with that of the guard rail.

The size of guard-rail bolts is ¾ in. diameter by 29¾ ins. long, with 4 in. thread. Under each nut there is an iron washer 2 ins. diameter and 1/16 ins. thick, and above each head an ogee washer. After screwing down nuts all guard-rails bolts are cut off flush with top of guard-rail. All threads on bolts or nuts are United States Standard, and all bolt threads are checked with center punch, or half-round blunt-chisel, after nuts are screwed home. In every case, at least two screw threads must project beyond outer thread of nuts after nuts are screwed home.

The diagonal bracing begins at first bent, and extends clear across bridge in triangular system, as shown in elevation. Generally, there are four lines of middle longitudinal braces extending one span beyond foot of slope. The remaining spans have two lines.

There are also generally four lines of lower longitudinal braces, also extending to one span beyond foot of slope, and beyond this panel two lines. If there is danger from drift or ice, these longitudinals in the last span extend from lower sill in one bent to middle sill in next bent, as shown in Fig. 1.

After the track has been laid across the bridge some rail joints will probably come over ties not fastened with guard rail bolts. Whenever this occurs, the general foreman is instructed to have one square boat spike ½ in. x 10 ins. driven through the tie and into the inner strand of stringer. Bridges 1,000 ft. or more in length shall have hand-car turn-outs placed 500 ft. apart.

Special plans are made for any bents which measure more than 40 ft. 3½ in. from base of rail to top of bottom sill. It may be added that ordinary single bent bridges are similar to the upper half of the double-braced bents now described and illustrated. Their height, however, must not exceed 18 ft. from top of sill to bottom of cap.

[We are only able to give a part of the engravings this week. In concluding them next week we shall have something to say in regard to details of the designs, and other points touched on in this article, some of which seem to us open to question, although it will be at once clear that the designs contain many most admirable features. ED. ENG. NEWS.]

Charles Latimer.

(*With Portrait.*)

CHARLES LATIMER, whose lamented death occurred in Cleveland, O., March 23, was born in Washington, D. C. Sept. 7, 1827, and was therefore at the time of his death in his sixty-first year. He was fond of tracing his descent from the family of Bishop HUGH LATIMER, the English martyr, after whom he named his eldest son, and whom he certainly resembled much in character, if the connection was not very direct.

At the age of 14 Mr. LATIMER was appointed a midshipman and entered the U. S. Naval Academy at Annapolis, from which he graduated with credit well up in his class, remaining in the Government naval service some 13 years in all, one year of which was passed as Assistant Professor at the Naval Academy and the remainder chiefly in sea service. He then resigned and for a time served as an officer on a Mississippi River steamboat. His long and honorable career of railway service began in 1854, when he was 27 years old, and for three years he was successively rodman, leveller, transitman and assistant engineer on the Mobile & Ohio and Mississippi Central & Tennessee R. R's. From 1857 to 1861 he was again engaged in steamboat service for the Mobile & Ohio R. R., connecting that road with the Illinois Central.

When the war broke out, although Mr. LATIMER was of southern parentage and residence, he did not waver a moment in his allegiance, but became a vehement Union man and immediately entered the Government service in the field where he was deemed most useful, as Assistant Engineer in the U. S. Military Railways service. Here he was at once engaged in rebuilding and maintaining various roads in Kentucky and Tennessee, ending his service with Col. WRIGHT in Chattanooga in 1864-5. His military service, while full of interest and successful exertion, was not particularly brilliant in incidents, but in connection with his previous experience as a naval officer it undoubtedly laid the foundation for Mr. LATIMER'S most remarkable trait, his notable executive ability in the selection and management of men.

After the war Mr. LATIMER returned for a short time to steamboat service, commanding one of the boats on the line above mentioned, but in 1867 he returned to engineering work on the St. Louis, Vandalia & Terre Haute and Dixon, Peoria & Hannibal R. R. (now of the C. B. & Q. system) of which he was Principal Assistant Engineer.

In 1871 he became Principal Asst. Engineer of the Chicago & Michigan Lake Shore R. R., and in the following year the company recognized his ability by appointing him Chief Engineer. Later, Mr. LATIMER accepted a position as Principal Assistant Engineer on the extension of the Hannibal & St. Joseph Railroad, and was thus employed for six months, when he becams connected with the Atlantic & Great Western, since known as the New York, Pennsylvania & Ohio Railroad, which is now a part of the Erie system. This was Jan. 1, 1873.

For three months he was assistant engineer, for one year Principal Assistant Engineer and in 1874 he was chosen Chief Engineer, which position he held constantly until March, 1886, when the consolidation of the road with the Erie and a change of management led to his resignation.

The position of Consulting Engineer or engineer for the lessor company was then tendered him, and he held it to the day of his death, engaging likewise in various consulting work. It was a desirable office for the company to have, but it was beyond doubt created more in recognition of Mr. LATIMER'S past services and in view of his intimate personal knowledge of the road than from the idea that it was inherently desirable if filled in ordinary fashion.

Mr. LATIMER became a member of the American Society of Civil Engineers, April 5, 1876, and was last year President of the Civil Engineers' Club of Cleveland, in which organization, as in everything for the advancement of his profession, he took a great interest. He married in 1866 a Miss LOMBARD of Illinois, a woman of many noble qualities, and a true, devoted and unselfish wife, who died in 1875 leaving four children, three daughters and one son, who still survive Mr. LATIMER. As is the case with so many men, much of Mr. LATIMER'S success in life, and many admirable traits of his character were beyond question due to or strengthened by her influence.

The work on which Mr. LATIMER'S reputation as an engineer will chiefly rest was his long and successful conduct of the Engineering Department of the New York, Pennsylvania & Ohio Railroad. That department was organized in a somewhat unusual way. The Chief Engineer not only had full control of engineering work proper but of the track department and track force as well, reporting only to the President, thus giving him very unusual power and responsibility. When Mr. LATIMER began his duties the road had been for years in complicated financial difficulties, as it continued to be during most of his administration. A most ill-judged and badly laid out enterprise in the beginning, it had and has no hope of real prosperity, and during its years of independence, with the Erie its only eastern connection and taking full advantage of that fact, there was the greatest difficulty in even meeting operating expenses. As a consequence the track was at first in fearful condition. Run-offs were frequent, and the outlook for much improvement was poor. Mr. LATIMER took hold of the work with characteristic energy, organized his department with great care, began at once the system of exciting the personal interest and emulation of employès which continued throughout his management, and as a final result, when his chief engineership closed, he was able to show a track the equal of any road in the West, obtained by very moderate annual expenditures, and with the proud record that in his whole tenure of office not a single passenger had lost his life or been seriously injured from accidents due to defects of track.

The result alone was something to be proud of, but even more interesting than the result was the manner in which it was obtained. Intensely interested in the work himself and strongly sympathetic in his nature, he early established between himself and his subordinates, high and low, the relation of friend and fellow-laborer rather than that of master and servant. Annual "Roadmasters' Meetings" were established early and continued during his administration, at which every question of track administration was discussed frankly, and suggestions were always welcomed and duly weighed. A regular system of inspections was also established on this road among the first. No money prizes were awarded, for Mr. LATIMER would not countenance the idea that the men needed it to stimulate their fidelity, but praise and blame was carefully and equitably distributed. The same general system of management naturally permeated down through the force into the lower grades. The result was that friendly rivalry and *esprit du corps* were greatly stimulated, and each man had to a great extent the advantage of the united intelligence of the whole force in conducting his work, as well as the feeling that any slackness would be noticed and commented on.

Perhaps Mr. LATIMER'S greatest single service to engineering was the invention, in 1871, of the re-railing guard which bears his name, which is now almost universally approved, and soon, we cannot doubt, will be as universally used. The first one of these was put in at the St. Joseph river bridge, on the Chicago & Michigan Lake Shore road, of which Mr. LATIMER was Chief Engineer, and within two years thereafter saved two passenger trains from wreck. The elements of this invention were not new; in fact, had so little novelty that patent was refused on them, but none the less Mr. LATIMER deserved the credit of developing heretofore crude and imperfect forms into a perfect and satisfactory device. He finally was deceived into taking out one of those sham patents which patent nothing, as explained in our issue of May 7, 1887, but he for years offered the use of the device freely to any one who wanted it, and at last sold it for a song ($300) to other parties.

Mr. LATIMER was known outside of his profession more by two particular beliefs of his than as a civil engineer, viz., by his belief in the "divining rod," and by his vehement advocacy of the divine origin, in the pyramid of Cheops, of our "Anglo-Saxon weights and measures." The divining rod he had believed in almost from his youth. He claimed that not simply a forked witch-hazel twig, but any other kind of wood, or even a bit of wire or other material, would suffice for the purpose, and that it was possible to locate not only water but minerals and metals below the surface, and not only to locate them but to tell their depth and the thickness of the vein. He was always ready to attempt to prove this by locating water pipes, coal veins, and other known deposits, and certain it is that he had some remarkable successes, the most notable being the Witch Hazel coal mine, near Youngstown, O., where he correctly located the vein, its depth and thickness, in a locality where there was much irregularity and uncertainty in these matters. For this service he received $5,000 cash and a royalty of 12½ cts. for every ton of coal mined, which still belongs to his estate. Many wells were also located by Mr. LATIMER, but he had not a few failures as well. He published a book on the subject in 1876.

In 1878 Mr. LATIMER read Prof. PIAZZI SMYTH'S now famous work "Our Inheritance in the Great Pyramid," and immediately became convinced of the divine origin of that structure, and that it was built largely to divinely sanction the "British inch." The force of his character and his power as a leader was never better illustrated than by the way in which, there being then practically no one in the country who took the slightest interest in the matter, he succeeded in organizing an "International Institute for Preserving and Perfecting Weights and Measures," which now numbers hundreds of members, publishes a monthly magazine with a large circulation, and is widely known throughout the country. Not one in ten of the members, to the best of our information and belief, felt any great personal interest in the matter, but they were carried away by the magnetism of Mr. LATIMER'S enthusiasm, and now that he is gone we shall be surprised if the organization has coherence enough apart from him to hold together.

It is to be feared that these two personal idiosyncrasies, which to many seemed a belief in mere absurdities, have led even engineers who did not believe in them to do scant praise to Mr. LATIMER'S sterling qualities and really great abilities as an engineer and manager, and to forget during his life the homage due to a nobility of character, a generosity of spirit, and a purity and unselfishness of life which was more than admirable, and which will be long and tenderly remembered by those who had the good fortune to know him intimately. A more entirely unselfish man perhaps never lived, nor one who was less stimulated by mere personal ambition. Had he been more so, his professional career would undoubtedly have been even more successful, but he would hardly have left behind him in as great measure what would have been far more precious in his sight, the affectionate remembrance and good will of all who knew him, from the lowest trackman to the late Chief Justice of the United States. He was by no means slack in discipline, and could easily be stern upon occasion, but he was invariably just, and hence it is doubtful if he had or ever had an enemy in the world. Profoundly religious and believing himself, he was singularly tolerant of those who were not, and was as far as possible from the "unco' guid" manner which is often so offensive in the pseudo-religious.

It was Mr. LATIMER'S habit for years to have family prayers night and morning, and his death was consistent with his life in that he was stricken with apoplexy on his knees, after his morning prayers. Beyond a few incoherent words after he had been helped to his bed he never spoke again, and he lived but a few hours. Could he have foreseen the stroke, he would have been the first to say, "It is well," nor do we believe his composure would have been disturbed for a moment.

His funeral was a remarkable evidence of the universal respect and regard in which he was held. Six of his old roadmasters acted as pall-bearers, Messrs. M. J. MCINARNA, P. BOWEN, P. COLLOPY, E. COLLOPY, T. G. ARMSTRONG and J. HALLER, and undoubtedly he had no truer mourners. Twenty Civil Engineers acted as honorary pall-bearers and escort, and the church was crowded with high and low of Cleveland, a Sunday School class of a dozen Chinamen whom Mr. LATIMER had taught for years, and who sent in one of the finest floral tributes, being especially conspicuous.

"A life of honor and of worth hath no eternity on earth; 'tis but a name," and the memory of Mr. LATIMER, with that of many others less worthy, will gradually fade away, but it would be well for many men if they could appreciate and imitate his noble qualities, while their memory is yet fresh; as it will surely be while those live who have known him intimately.

The Comparative Value of Different Classes of Fireproof Ceilings.

We find in the London *Building* a full account of an interesting experiment on the comparative value of different classes of fireproof ceilings which was recently made at Birmingham, England. A brick building ten feet square was constructed, and the ceiling was divided into four compartments by means of iron girders carrying brick walls a short distance above, to prevent fire spreading from one compartment to another. The ground floor of the building, which was not divided, was completely filled with dry firewood saturated with paraffin, and when this was well alight the heat was very intense, much more so than it would be in the case of an ordinary outbreak of fire. One of the compartments above represented an ordinary floor with a ceiling underneath, with an additional layer of boards nailed at the bottom of the joists, the under side of these boards and the under side of the joists being coated with asbestos paint, and pugging placed over the boards. In another compartment were a floor and ceiling, with asbestos mill-boarding nailed on the under side of the joists. Another contained a similar floor and ceiling, with "silicate cotton" in place of mill-boarding. The fourth compartment was an ordinary floor and ceiling, without any counter-ceiling. The compartment containing the unprotected ceiling and floor was burnt through shortly after the fire got well alight. The compartment containing the counter-ceiling and pugging lasted for an hour and twenty minutes after the fire was started.

The next floor to burn through was the one under which the asbestos mill-boarding was nailed. This occured an hour and thirty-five minutes after lighting; and the remaining floor, containing the silicate cotton, was practically intact when the fire was extinguished, after burning an hour and forty minutes. One of the girders (in this case a steel tramrail) dividing the compartments gave way a little in the center, owing to the intense heat, and this caused the fire to be communicated to the joists over the silicate cotton. Otherwise this compartment was uninjured. In the opinion of the experts present the test appeared to prove that this material securely fixed to the under side of the joists will effectually prevent a fire from reaching the floor above. The "silicate cotton" protection consists of a layer of the material enclosed between two layers of wire network. The effectiveness of the asbestos mill-board appeared to have suffered from the giving way of the nails by which it was fastened to the under side of the joists. The London *Illustrated Carpenter & Builder*, in reporting the experiment, makes the questionable deduction that even the ordinary plaster ceiling may be sufficient in many cases to prevent a fire penetrating directly to the floor above.

ENGINEERING NEWS.

THE strikes about Chicago have shown a constant tendency to spread, but are carried on in a half-hearted and desultory fashion, which seems to indicate that the ultimate triumph of the companies is almost certain. A pleasing feature has been the comparative absense of rioting and lawlessness, and the evident fear of and the respect for the authority of the Government, as embodied in the Interstate Commerce-law.

IN the meantime, two great corporations, the Pennsylvania Railroad, on one side and the Pittsburg Traction Co. on the other, have been teaching railway employees how to pay respect to law and order by a little war of their own at Pittsburg, Pa. The Traction Co. wanted to pass over the Pennsylvania tracks and began work for that purpose. A force of Pennsylvania men then appeared, and cut the tackle and took down the platforms of the enemy. As a further protection artillery was brought into action, in the form of three big Pennsylvania locomotives, which were stationed under the proposed structure, to emit clouds of steam, sparks and smoke and so keep the enemy at bay, the wheels being permitted to "spin" without moving the engines by greasing the rails. The Traction people, in their turn, turned a stream of water upon nese thegines, and so drove them away, and they had almost completed their work, when their supply of ammunition (i. e. water for their hose) gave out and the Pennsylvania in turn advanced its force, lassoed the almost completed structure, and pulled it to the ground with a locomotive. The frequency with which this kind of warfare is resorted to by men who are supposed to be intelligent, should lead to more charity in considering the vastly more pardonable follies of striking workmen.

THE new St. Paul cable railway on which a serious accident occurred some weeks since, is stated to be rendering very bad service, and it is especially noted that the cars are moved forward by series of jerks which make it almost impossible to stand in one of the cars. According to the local papers, there have been too many "improvements" introduced in the plans.

AFTER April 10, four car trains will be run on the Brooklyn bridge, with the headway between them shortened from 90 to 80 seconds. In this way, it is expected to increase the present capacity of 12,000 passengers, or 120 cars per hour, to 16,000 passengers per hour. In semi-official statements, 19,000 to 20,000 are mentioned as a maximum; but this is impossible without crowding more people into the cars; and the running of four car trains on such short headway, and with heavier switching engines will prove, we fear, to seriously multiply the difficulties of continuous and smooth operation. It is, however, for the present, a practical necessity.

A NEW pipe line to Philadelphia, is proposed in opposition to the Standard, in connection with a large refinery at Philadelphia. It leads chiefly from the Washington territory, which has a present output of 4,000 bbls. per day; but will also reach most of the fields in West Pennsylvania. The pipe is to be of 8 in. diameter, and will probably be continued to the New York and New Jersey sea coast. The surveys have been made already; and advertisements for bids will be published soon. It is expected that the line will be completed this fall. The company will be known as the Western and Atlantic Pipe Line Co.

CORRESPONDENCE.

The Largest Arch.

ST. PAUL, Minn., March 27, 1888.

EDITOR ENGINEERING NEWS:

The Chester arch of 200 ft. span *is not* the second largest in the world but the third, the beautiful "*Pont de Lavaur*" in France being second and the Cabin John bridge the first.

The *Pont de Lavaur* is on the line of railway from Montanbau to Castus; its span is 61.5 meters or about 201.8 feet and was built in 1884. Full particulars of construction and dimensions of this arch as well as two others of large span ("*Pont Antoinette*" 164 ft., and "*Pont du Castelet*" 135.2 ft.) are given in vol. 12 of *Annales des Ponts et Chaussées*, for 1886.

A complete table is also given of all the large arches of the world with much valuable information in regard to their dimensions; if you should reproduce them in ENGINEERING NEWS, I am sure they would be of much value to your readers.

RANDELL HUNT.

A Hydraulic Conundrum.

MEMPHIS, Tenn., Feb. 12, 1888.

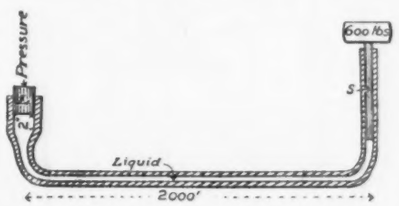
EDITOR ENGINEERING NEWS:

A cylinder, whose piston has an area of 10 sq. ins., is connected with another cylinder, whose piston (*S*) has an area of 2 sq. ins., by a pipe whose length is 2,000 ft., and sectional area 2 sq. ins.

The space between the respective pistons is filled with a liquid, say water.

Piston *L* can only move two inches, consequently after it has traveled this distance a pressure which may be exerted upon it *will not* be transmitted to the liquid.

Piston *S* by virtue of a weight offers a resistance of 300 lbs. per sq. in., making a total resistance of 600 lbs. Piston *S* is free to move as far as the liquid moves in the pipe, being about 10 ins.



A pressure is applied to piston *L* in proportion to time until at one-twelfth of a second the pressure is 24,000 lbs. [We presume our correspondent means a pressure increasing at a uniform rate from 0 to 24,000 lbs. in one-twelfth second.—ED.] This pressure then decreases until in another twelfth of a second the pressure is reduced to zero.

1. Will the piston *L* travel the 2 ins. in this period of one-sixth of a second?

2. If so, how soon after pressure is first applied will piston *L* travel the 2 ins.

3. How quickly will piston *S* feel the effect of a pressure on piston *L*.

4. Inasmuch as piston *S* after 300 lbs. per sq. in., acts as a safety valve, what pressure per sq. in. will be exerted on the pipe, even though the 24,000 lbs., the heaviest pressure, be required to make piston *L* travel the 2 ins.

5. What should be the outside diameter of a wrought iron pipe to withstand the pressure?

Very truly, J. B. R.

Explanation of the Old Nautical Instrument.

NEW YORK, April, 3, 1888.

EDITOR ENGINEERING NEWS:

In reply to your correspondent's question in your last week's issue, as to an "Old Nautical Instrument": It is an old quadrant. By having two arcs, instead of having the large arc go over the full 90°, the instrument becomes far less bulky. To reconstruct it in its *simplest* form: Put the sight vane shown in drawing, on the large arc and *put another vane at the point at the centre of the two arcs.* This vane may have a cross-hair in it. From the center of this vane and of the arc of the instrument let drop a plumb line crossing the small arc. Fasten the quadrant in such a position that the plumb line cuts 0 on the small arc, look at the object through the sight vane on the large arc, and the vane at the center. If horizontal the index will read 0 on large arc. If over 25°, depress the arc so the plumb line cuts any point on the small arc. To get the altitude add together the two readings. If the instrument is held in the hand it requires two observers (not counting those necessary to estimate errors).

By taking off the plumb line and looking from the central vane to a vane on each arc you get horizontal angles. An improvement on the general type of instrument, and Mr. MESEROLE'S may be one of them, had an index bar and a level, so that the bubble could be seen at the same time on the object observed. The bar was kept level and the arc was moved. Of course no horizon was used with this instrument. They gave the angle from a horizontal line—a right angle from the plumb line. The reflecting quadrant, invented separately by HADLEY & GODFREY, took the place of all these instruments. It is very surprising that the sextant in its present perfection is not more used in engineering work. It is the queen of instruments.

If Mr. MESEROLE will tell us whether there are any other places for attachment, we can get at any particular points about his instrument. It may have had an index bar, but I think not from the drawing. The diagonal scale on the large arc shows parts of degrees. Yours truly,

JOHN C. GOODRIDGE, JR.

[We are gratified at receiving so prompt and full an explanation of this old instrument, which we must confess puzzled us, and agree with Mr. GOODRIDGE that the sextant is an instrument too little used, especially in surveying.—ED. ENG. NEWS.]

Cement for Cellar Bottoms.

University of Illinois.
CHAMPAIGN, Ill., March 30, 1888.

EDITOR ENGINEERING NEWS:

A correspondent asks, in your issue of March 24, "the proportions of lime and sand to use with Rosendale cement for a cellar bottom." That depends upon the quality of floor desired, and the amount of money he is willing to pay for it. The best floor would be composed of clear Portland, the cheapest of sand alone; between these it is possible to have an infinite number of combinations of Portland and sand, Rosendale and sand, lime and sand, or lime and cement and sand. The object of my former paper was to show the relative strength of these various combinations, and also to give the data necessary to compute the cost of any particular mortar. Each one can take his choice, and pay his money accordingly.

However, the inquiry suggested another phase of the question, which the writer has treated in another part of this issue. Yours truly,

I. O. BAKER.

Transit Stolen.

CHATTANOOGA, Tenn., March 28, 1888.

EDITOR ENGINEERING NEWS:

Some time between 6 P. M., March 24, and 4 P. M. of the following day my transit and box were stolen from the office. The instrument was a double vernier surveyor's transit, with circle, level, clamp, and variation arc, made by W. & L. E. GURLEY, but the circle had been taken off. In place of the ordinary diaphragm a stadia diaphragm on which the wires were not quite correctly spaced, had been substituted. The box had been changed so that the instrument could be placed in it without separating from the levelling head, and the top of the box was bright and new, while the lower part was older and darker looking. The tripod was not taken.

The instrument was in good repair, and I can ill afford to lose it. Will you kindly insert this in the NEWS, with the request that if an instrument agreeing with the description given should be offered for sale or come to the notice of any your readers, he will promptly notify me? Yours truly,

Box 430. BENJ. THOMPSON.

Speed and Grades.

DILLON, Col., March 21, 1888.

EDITOR ENGINEERING NEWS:

In your discussion on March 10 of the question raised by my letter of Feb. 25, relative to the adjustment of switchback grades, there are one or two points which do not seem clear to me.

You say, in speaking of the ability of a slowly moving train to overcome the increased grade on the tail track of the switchback:

"Now, that train has been running perhaps 4 or 5 miles up hill and in each mile has risen about 106 ft., or perhaps 500 or 600 ft. in all. How much more work will that engine have had to do to approach the head block with a speed of 12 or 15 miles per hour instead of laboring along at the 6 or 8 miles per hour which our correspondent assumes?

Obviously, enough more to have lifted the train

through the difference between the velocity heads due to 6 or 8 and 12 or 15 miles per hour, which is 3.83 and 5.72 ft. respectively. * * * The engine has to do somewhere on the preceeding 4 or 5 miles about 1 per cent. more work in order to approach the switchback at 12 to 15 miles per hour instead of 6 or 8."

I can readily see how this could be done *if* 1 per cent. of the work done by the engine on the last 4 or 5 miles be suddenly added to its efficiency through a distance of say 500 ft. at or near the head block and just before the increased tail grade is met, thus increasing its power some 40 or 50 per cent. at that point, but this would seem out of the question in an engine already working to its full capacity.

Now, to increase the work of the engine by 1 per cent. over this 4 or 5 miles distance, would seem to be simply a slight increase in the rate of speed over the same ground and not to store 1 per cent. of the work done through 4 or 5 miles to be suddenly expended at some point beyond.

On this basis, with a run long enough, almost any obstacle could be overcome. Add 1 per cent. to the work of an engine, and in this distance it would of course be capable of raising its load some 5 ft. higher in the same time, but with the slow speeds under consideration could only do it on a very nearly continuous grade, and could not overcome the 15-mile grade adjustment under discussion—at least so it seems to me.

In regard to a train being very nearly stalled while moving at a 6 or 8 miles an hour speed, I think such would be the case on light grades where comparatively large driving wheels were used, but not so with very heavy grades, and the small-wheel engines used on them where the piston movement and exhaust affecting combustion would be 40 or 50 per cent. more than at the same speed with the large wheel engine—like the long lever moving with a short bite.

I have several times timed such engines with freight trains and occasionally a passenger train on 4 per cent. grades at rather less than 8 miles an hour, which seemed in no danger of stalling.

Of course the slackening of the grade near the head-block and the use of sand under some conditions, as explained, would remedy things, but the question was raised on another basis.

Yours truly. J. Q. BARLOW.

[Work done anywhere in excess of the retarding resistances will be stored in the train in the form of increased velocity, and will remain in it undiminished, in the form of such increased velocity, until destroyed by increased resistances. "Simply a slight increase in the rate of speed" is all that is needed. A train moving at 15 miles per hour, however far back that velocity was acquired, will lift itself 8 ft. (7.99) above the normal grade line it is working on before it will stall; at 6 miles per hour only 1.28 ft., and at 8 miles per hour only 2.27 ft. Small-wheel engines are somewhat less likely to stall than others, for the reasons stated, but any engine at these speeds is in imminent danger of stalling from any chance irregularity of grades, curves or head winds, amounting to 1.28 ft. more lift than the normal, simply because it has no stored energy to carry it over them fly-wheel fashion, and not at all because the pistons go so slowly. On the other hand, a train moving at 60 miles an hour will "float" over a hill 39 ft. high and only lose 10 miles an hour of its speed.—ED. ENG. NEWS.]

The Market Street Cantilever Bridge.

PHILADELPHIA, Pa., March 27, 1888.

EDITOR ENGINEERING NEWS:

With your permission I desire to make a comment on an article published in your columns, in which the author makes an unjust criticism, which I think he will modify after he has been informed of the conditions under which the structure was designed. I will admit, however, that the remark is natural, when viewed from the standpoint taken by him; he being entirely ignorant of the special conditions of the case.

I have reference to the extract in the article written by Mr. GUSTAV LINDENTHAL in your issue of March 3, 1888, in which he says:

"And another large city could be named where another ugly looking cantilever bridge has actually been put up with the aid of false works."

It is not to be denied that the "cantilever fever" is prevalent at the present time, but it had no influence whatever in this case; the true cause being, that no other style of bridge would meet the requirements, and at the same time cover the conditions imposed. I take pleasure in informing Mr. LINDENTHAL of those conditions, and I trust he will at once see why a cantilever bridge was "actually put up with the aid of false works."

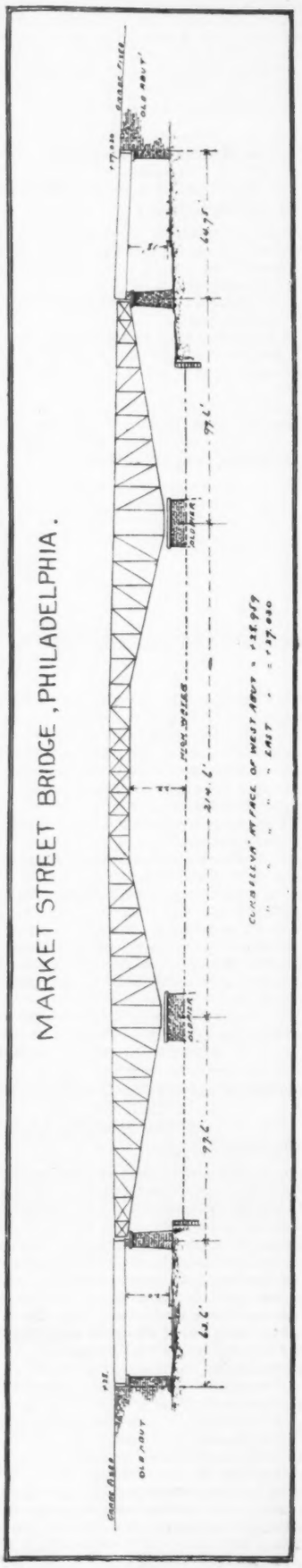
In *no case* would any but a deck bridge be accepted. It was insisted upon, that we should utilize the old abutments and foundations of river piers, placed there for the original structure.

Sufficient clearance had to be given for the Pennsylvania Railroad on the west side of the river, and the Baltimore & Ohio Railroad on the east side.

We were compelled to allow sufficient headroom in channel of river for navigation, and at the same time must obtain an easy grade for roadway on bridge.

The cantilever design was considered the only one that would meet these requirements; an additional advantage being that the thrust of an arch was avoided, it being *imperatively necessary* that this element be eliminated from any design used, as it has been the cause of very serious trouble in the past, in the experience with other bridges over this same river in this vicinity. I herewith take pleasure in submitting a sketch of the bridge, and if Mr. LINDENTHAL can suggest any better way of surmounting the difficulty, accepting the same conditions, I would be very much pleased to receive his suggestion, as I am always very willing, in fact eager to obtain any valuable ideas. Yours very truly,

F. J AMWEG, M. Am. Soc. C. E.

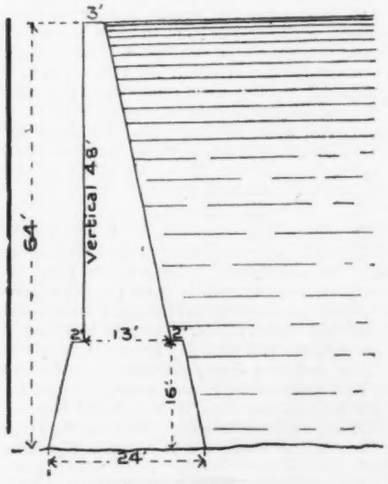


Two New California Curved Dams.

NATIONAL CITY, Cal., March 19, 1888.

EDITOR ENGINEERING NEWS:

I have been much interested of late in the elaborate reports of Messrs. CHURCH and FTELEY on the Quaker Bridge dam, recently published in ENGINEERING NEWS, and have followed the editorial discussion of the subject with equal interest. It appears to me that you have made out a most unanswerable argument in favor of a curved masonry dam, as against a straight dam—applicable not only to the conditions at the proposed Quaker Bridge dam, but to any situation where a masonry dam is to be constructed. I have just finished the construction of a masonry dam, of which I send you two views [engraved herewith] on the Sweet Water river, some miles east of this city, which evidently ranks first in height among structures of that class in the United States. From the lowest foundation to the top of the parapet its height is 98½ ft. It is 46 ft. thick at the bottom, 12 ft. thick at top and 360 ft. in length on the crest. It is built in curved form



The Bear Valley Dam. F. E. BROWN, Engineer.

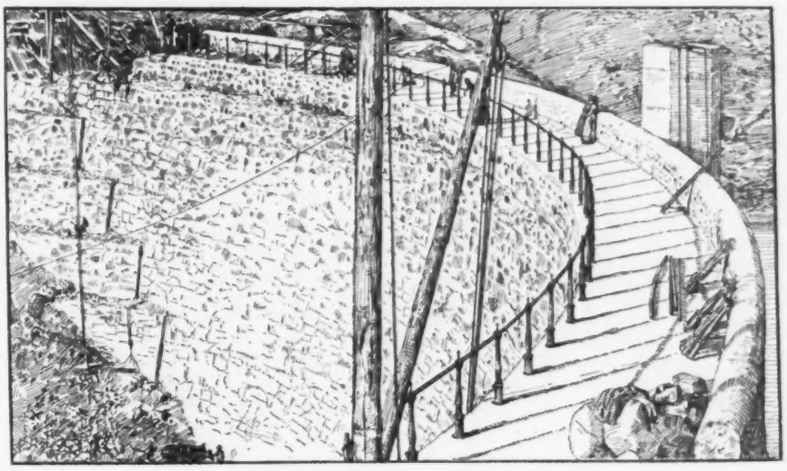
on a radius of 213 ft. In designing it I adopted a gravity profile, but considered the curved form as indispensable to its safety, and to its *appearance* of stability. I arrived at this conclusion after a course of reasoning very much in the line of what you have so clearly expressed in your editorial comments on the subject in your issue of Feb. 4 and Feb. 25. The unusual weight of the stone used, most of which exceeds 190 lbs. per cu. ft., led me to trim down my profile to the dimensions given. The character of the masonry is a rough rubble, laid in a mortar of Portland cement and sand in the proportions of 1 to 3. The water in the reservoir has risen to within 24 ft. of the top and is still rising. It shows no evidence of weakness, and I have the utmost confidence in its stability.

Your reference to the Zola dam as the only masonry dam in existence relying upon its arched form solely for its stability, leads me to call your attention to another structure in Southern California, which is little known, as no description of it has ever yet appeared in engineering journals as far as I know. This dam was built some four years ago in the mountains of San Bernardino, at an altitude of 4,000 ft., in a narrow gorge at the outlet of Bear valley, which by means of the dam has been converted into an enormous storage reservoir, for the supply of extensive irrigation works in the San Bernardino valley. This dam is of most startling dimensions. Its extreme height is 64 ft.; thickness at top *three* feet, at a point 48 ft. from the top it is but *thirteen* feet, where a square offset of about two feet is made on each side. The thickness at bottom is 22 to 24 ft. I have not the exact dimensions, but I understand it is about 450 ft. long on the crest, and is built in a curve whose radius is some 300 ft. It is vertical on the back, and is built of granite, cut in block and laid in Portland cement.

Here is a dam that is without a parallel in the civilized world, so far as I have been able to learn—the most ultra radical of the pure arch type—and yet it has stood with a reservoir brimming full every year back of it, for nearly five years, and still awaits the earthquake that is to effect its ruin. For the lessons which this daring experiment may teach I think it is worthy of more attention than it has received at the hands of the profession. Its remoteness and difficulty of access accounts for the meagre information obtainable regarding it. But with this in view the Zola dam cannot longer be regarded as the sole representative of a class relying upon the arch alone, for stability under pressure. The engineer of the Bear Valley dam was F. E. BROWN of Lugonia, San Bernardino Co.

Another point: Mr. CHURCH, in his report states that he has worked out a formula which proves "the fact" that the pressure on voussoir joints increases as the radius increases, and hence, by reason of the wide span at Quaker bridge, the radius required is so large that the monstrous section he shows us is needed to obtain requisite area of voussoir joints over which to distribute the pressure. Are we not to infer from this that a dam on a curve of infinite radius, viz. a straight line, would give as infinite pressures on voussoirs, requiring cross-sections of infinite magnitude, and that after all the straight dam he advocates is an impossibility according to his own formula. Is there not something *very peculiar* about his formula?

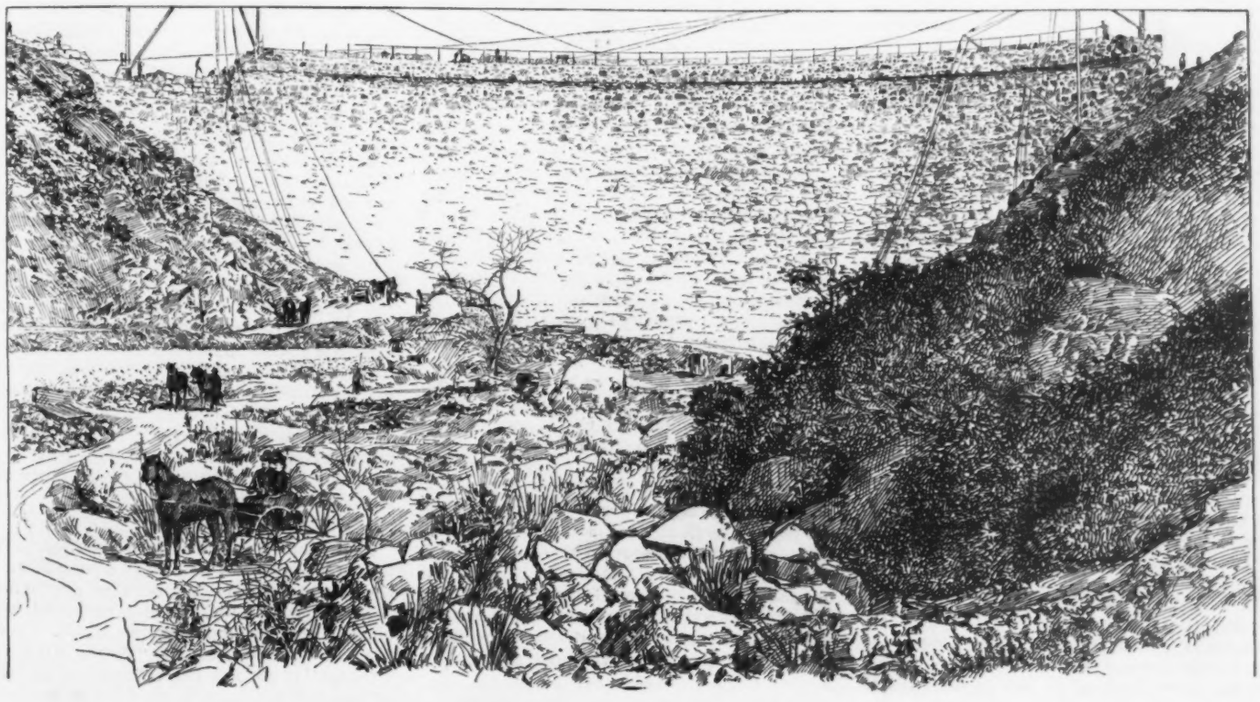
Yours very truly, JAS. D. SCHUYLER.



The Sweet Water Dam.

[We have taken the necessary steps to obtain full details of the very interesting arched dam of which our correspondent gives a brief description, and which we must confess we had not heretofore heard of. It is plainly a work of the greatest engineering interest, and in connection with the Zola dam goes far to show that the reasoning by which it is attempted to show that very high curved dams cannot act both as arched and gravity dams to a very considerable extent is fallacious. The Bear Valley dam is a vastly bolder work than the Zola, as the following comparative details will show:

	Zola.		Bear Valley.
Extreme height	126	ft.	64 ft.
Height to water line	122	"	— "
Thickness at top	19	"	3 "
" 48 ft. from top	—	"	13 "
" at bottom	41.9	"	22 to 24 "
Length on crest	205	"	about 450 "
Radius of crest	158	"	" 300 "



The Sweet Water Dam, near San Diego, Cal. JAMES D. SCHUYLER, Engineer.

For the very reason that the Bear Valley is so much lower the complete reliance placed on the arched form for stability makes it the bolder and more interesting structure. It is easy enough for the top of a very high dam to act as an arch; for the bottom to do so seems all but impossible, yet the Bear Valley must do so not far above the bottom.—ED. ENG. NEWS].

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D. McN. STAUFFER. A. M. WELLINGTON. EDITORS.

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club of Philadelphia, Pa.—Regular meeting, April 7. Secy., Howard Murphy 1122 Girard St.

Association of North American Railroad Superintendents.—Next meeting in New York, April 9.

Civil Engineers' Club of Cleveland, O.—Regular meeting, April 10. (Civil Engineering branch of the club). Secy., C. O. Arey, 31 Blackstone Building.

New England Railroad Club.—Regular monthly meeting, April 11. "Heating Passenger Cars by Steam." Secy., Francis M. Curtis, Old Colony R. R. Co., Boston, Mass.

American Water-Works Association.—Annual meeting at Cleveland, O., Apr 17, 18, 19. Secy., J. H. Decker, Hannibal, Mo.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, April 18. Secy., S. E. Tinkham, City Hall.

Engineers' Club of St. Louis, Mo.—Regular meeting, April 18 "Gas Producers," C. M. Woodward; "A Well Ventilated Mine," Lewis Stockett. Secy., W. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, April 18. Secy., John Bogart, 127 E. 23d St.

American Society of Mechanical Engineers.—Meeting at Nashville, Tenn., in April or May. Secy., F. R. Hutton, 280 Broadway, New York City.

Engineers' Club of Kansas City, Mo.—Regular meeting, May 7. Secy., Kenneth Allen, 19 Deardorff Building.

Master Car Builders' Association.—Next convention at Alexandria Bay, N. Y.; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy., Angus Sinclair, Chicago.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reed, Waycross, Ga.

THE very interesting letter from Mr. JAMES D. SCHUYLER, M. Am. Soc. C. E., as to two remarkable California dams, which appears in another column, must be read with interest by all engineers, especially in the details which it gives of the bold Bear Valley arched dam, which has heretofore escaped proper technical record.

In what Mr. SCHUYLER says of his motives for adopting the curved form for his recently completed Sweet Water dam, the highest as yet in this country (although the San Mateo, 170 ft., now building in the same State, is still higher and almost the highest in the world,) we have a new indication of the truth of our surmise, in discussing the design of the Quaker Bridge dam (ENGINEERING NEWS Feb. 4, 1888) that it was a perception of the inherent advantages of the curved type, and of the absence of any such "far superior strength economy and safety" in straight dams as was supposed, rather than the suggested lack of knowledge of the theory of the subject, which had led to the almost universal preference for a curved profile in very high dams. Certainly it is a significant fact that the three highest dams in the United States (with one slight exception) now building or just built in California by as many different engineers, have all been built of the curved type and with short radii, although differing materially from each other in most other details of design and construction, so as to show conclusively that they were not copied from each other. The Bear Valley dam is of by far the greatest engineering interest, because of its bold and successful reliance on the "most ultra radical" of arch profiles, the mere gravity stability being a very small fraction of the whole. Certainly, if the Zola arched dam is in the least danger of failing, as has been suggested, the Bear Valley should have failed long ago.

THAT there was a large saving in material in in adopting the arched type for the Bear Valley dam is evident. That the same thing *could* be done at Quaker Bridge is highly probable, although no engineer in his senses would advocate the experiment on so important a structure. What is gained, however, by adopting the arch type without attempting to save material, is a very decided increase in the normal coefficient of safety, with a still larger and indeterminately greater increase in case of abnormal or irregular strains; and as this is very desirable even if it is not *sure* to be needed, and as it can be obtained in a straight dam only by a great increase of section, the curved type even in this case may be said to save material, as well as to give a far more graceful structure.

That there is less inherent difficulty than has been supposed in a dam acting both as an arch and as a gravity dam seems to us to be indicated by a line of reasoning somewhat like the following, as well as by the facts of experience: Conceive, for illustration only, a dam of the pure arch type, of thin rectangular cross-section so as to have no appreciable gravity stability. Conceive the dam to be made up of successive horizontal arches with key-stones vertically over each other. The thrust in each arch will increase with depth, but the spans will decrease with depth, under the ordinary practical conditions, so that the tendency to "settle at the crown" (move horizontally) will be approximately equal in each. If now we adopt a triangular in place of a rectangular cross-section, we increase the areas and decrease the unit pressures from arch thrust as we go down, and hence decrease compression and consequent horizontal "settlement" of the arches; in other words, we introduce a tendency in the water face of the dam to rotate about its lower edge. But this is precisely the tendency which results from the elastic action of the mass in respect to gravity stability, which latter we have at the same time introduced by adopting the gravity section. Hence the two act perfectly harmoniously together, and there will be a certain size of triangular section (theoretically, practically it could not be exact) at which precisely half the stability will be due to arch action and half to gravity action, each acting without any appreciable conflict or interference with each other.

THAT some such action of strains as we have outlined is that which exists in such a dam as the Bear Valley, and in less degree the Zola, seems to us clear. There is no point at which they cease to act by gravity and begin to act as arches. The two actions co-exist throughout the mass in varying yet approximately constant proportions, and the supposed necessity for some tearing apart of the joints where arch action is to begin does not exist either in fact or theory. By varying the cross-section the arch action may be made more and the gravity less, or *vice versa*, and by adopting a heavy enough section the percentage of normal arch action may be made very small, *but it is always there*, and as it acts in a different plane from the gravity action, is always capable of instant enlargement to supplement the latter if from any cause it becomes insufficient. The contrary notion seems to us only defensible under two unpractical assumptions, that the cross-section of the valley is a rectangle and that there is no elastic motion of the mass under strain. If the latter assumption were to be carried to the point of building a dam 265 ft. high with parapet walls having no horizontal camber, there would probably be a speedy revelation of its unsoundness by an ugly bulge, when the full pressure of the water was let on.

WE have received a large number of letters and comments from engineers, some of them apparently intended for publication and some not, in reference to the plans recently recommended for enlarging the transporting capacity of the Brooklyn bridge and reconstructing its terminals. We should have been pleased to publish several of them, but when such communications are confined merely to commendation, as so far all of them have been, it does not seem fitting for us to occupy space with them. Had any critical, opposing or suggestive articles been received we should have been pleased to give space to them.

For like reasons it has not seemed advisable to reproduce any of the numerous articles on the subject which have appeared in the daily press, although they might have been examined with interest. All Brooklyn papers and nearly all of the New York papers have published articles strongly commending the plans, and none have opposed them with one curious exception: The New York *World* has just bought the lot on which French's Hotel stands, on the north corner of Frankfort St. and Chatham Square, opposite the *Sun* building, for $659,000, with the avowed purpose of erecting thereon a magnificent newspaper building which should dwarf creation in general and the *Sun* in particular. It is the only available location in the city adapted to that laudable end, and unfortunately it is necessary to condemn the whole of this lot, and throw most of it into a plaza, to carry out the plans for the larger terminal recommended by the experts; while the very recent sale of this building for the price named will furnish an awkward precedent for the price to be awarded in proceedings in condemnation. On the other hand the *Sun* lot will be greatly benefited by the proposed improvements, and become the most conspicuous and desirable newspaper lot in the city.

THESE facts, combined with devotion to the public interest, and disgust at a suggestion of the *Sun* that the land should be condemned before "costly buildings now projected were begun," were too much for the *World*. Under the appropriate head of "Never Mind the Millions" it devotes two columns of its issue of March 31 to letting in the light of day upon "the extraordinary proposition submitted to the Trustees by Engineer WELLINGTON, and recklessly advocated by a commission of three fellow engineers whose opinion had been sought,"—and who will now, we trust, at last be able to see themselves as others see 'em. A leading editorial entitled "Engineering on the Rampage" succeeds, from which we make the following choice extracts:

"The Trustees will be called upon at their meeting on April 9, to consider how to increase the number and size of trains on the Brooklyn Bridge. The plan to be submitted, with the approval of a Board of Experts, is de-

igned by Mr. A. M. Wellington, a civil engineer, and a criticism of its practicability and useless extravagance is published elsewhere in to day's World.

"In this report the Bridge Trustees will find themselves called upon to largely extend their functions. Besides managing the bridge and its finances, if they dopt the report, they will have to beautify the city, to make plazas, to open streets and to do other work with which they have heretofore had no concern. They are asked not only to furnish increased facilities for the ridge railroad passengers, but to provide depots for horse-car companies which are to run over the bridge; o supply accommoda ions for Elevated and Underground railroad termini, and to afford the public, on he projected "broad, spacious rotunda," the luxuries of waiting-rooms, parlor rooms, news-stands, toilet-rooms, refreshments-stands, cigar stands and, in the comprehensive language of the engineer's report, similar public conveniences, now lacking." Indeed the philanthropic engineer seems to have omitted from his liberal supply of the "public conveniences" of his grand rotunda emporium only a base ball ground and a free soup-house.

"To be sure, these flights of engineering fancy, if practicable, would entail upon the two cities an expense of at least from five to seven million dollars, or more han one-third and perhaps nearly one-half the cost of he bridge up to the present time. We do not believe that the sensible, sterling business men who compose the Board of Bridge Trustees are at all likely to involve the two cities in any such expenditure for mere show. The circulating system advocated by Mr. Wellington may be found to be the best plan for the relief of he present travel over the bridge railroad. If so it should be adopted on the smaller scale first proposed and without any fancy embellishments. In the future here will, beyond doubt, be other bridges over the East river, which will be likely to reduce the present bridge traffic even below what it now is. The matter can safely be left in the hands of the practical business citizens who, with the Mayors of the two cities, form the present capable Board of Bridge Trustees."

To appreciate the full humor of this serio-comedy it is necessary to remember that the "smaller scale first proposed" leaves the French's Hotel lot almost intact, that the estimates for the larger plans complete could possibly be inflated to $3,000,000, the interest on which is far more than covered by the saving in switching and other operating expenses, so that the new facilities will not really cost a dollar, and that the *World* and the "practical business citizens who form the present capable Board" have heretofore been at sword's points.

Whether true or not, the unique answer of the Chicago, Rock Island & Pacific Managers to the bill of complaint of the Chicago Burlington & Quincy, in which they averred that the latter corporation was endeavoring to form a "Railway Trust" and by its action in the rate war and the strike, was endeavoring to force its competitors to join this scheme under penalty of ruin, has naturally caused much thoughtful comment. The term "Trust" has come to have so evil a significance that in the popular mind the answer of the Rock Island will possibly create great prejudice against the Burlington in the stubborn fight which the latter is making, although it is far better to consider such questions in a cool and candid manner.

A trust, broadly speaking, is any device which aims to limit competition and fix the prices at which any commodity shall be sold. The output and price of steel rails is controlled by a trust. Within the last few months the price of copper has been doubled by cornering the world's supply. The various labor organizations all aim at one end, to force the wages of those engaged in any trade or occupation above the point at which they would stand if the law of supply and demand alone determined the price. Many of the other commodities of which railroads are large consumers are likewise held at far higher prices than would be the case if free competition existed. With these circumstances in mind, those who control the eight and a half billions of dollars invested in the railway transportation lines of this country should not be blamed too severely if they try to protect the property entrusted to their care by introducing similar tactics to those in force in other lines of trade.

Nor is this the whole statement of the case. In other lines of business competition is comparatively moderate, and only acts by the inexorable law of the survival of the fittest to prevent over-production or the lowering of the selling price below the cost. But railway transportation is entirely different. It is impossible for two competing railway lines to do business long without some device to limit competition. The character of railway competition is well expressed by the term "rate war," for it is a war indeed, and one which, if it continues long, must result fatally to one of the contending parties. As a matter of fact, railway competition has always been limited by some form of traffic agreement, pool or association, and must be from inherent necessity. The public has abundant power to protect itself from any monopolistic abuse by the rapidly developing system of state railway control, and it has no need to fear anything from the formation of a railway trust. It would rather be the gainer by the permanence and stability which would be given to railway rates and financial and operating management. Instead of attacking a railway trust, therefore, which if formed would be under legislative control, it would seem well for the public to consider how it shall treat those who are taxing the world by their control of its natural and mineral wealth and also those who threaten to paralyze the industries of a continent by their control of all the skilled workmen in a single trade.

A correspondent writes us:

Will you kindly advise me through the medium of your journal of the sharpest curve that a platform car of 28 ft. and 33 ft. in length will pass over on a 4 ft. 8½ in. gauge. I note in your issue of 24 last., page 218, under heading of "Horse Shoe Curves," that "freight cars pass over curves every day in the streets of New York and elsewhere of less than 50 ft. radius." I do not question the feasibility, but as there may be a misunderstanding on my part, I take the liberty of asking what are the possibilities in this respect for rapid transit and dummy lines.

The possibilities are about those stated. An ordinary freight car *can* go anywhere that an ordinary horse-car can, which is of the same gauge and a still longer wheel-base; and it not only can do this but does do it in New York and many other cities. Even dummy trains can and do run around curves of 75 ft. radius or less, hauling 6 or 7 loaded cars at slow speeds, and on the U. S. Military Railways, at Petersburg, Va., a curve of 50 ft. radius, 100° long, was built in haste for a mere temporary purpose, and was found to answer so well that "a very large traffic passed over it for months afterwards, supplying the armies of occupation in Richmond and at other points, and no accident or trouble whatever was experienced," all this being with ordinary locomotives and cars, and after the war was over, so that no military urgency demanded its continuance. The 90 ft. radius curves on the elevated railways of New York give not the slightest trouble, nor can they be regarded as an appreciable source of danger, with such guard-rail protection as they have and such car draw-gear, which connects the center pin of trucks and not merely the car-ends in the usual way.

Therefore almost anything *can* be done on a dummy or rapid transit road in the way of sharp curves, but the more irregular the speed is likely to be the more objectionable they are, and it would hardly be safe to attempt to operate trains of freight cars, taking them as they run in service, over sharper curves than 100 ft. radius, and that is very undesirably sharp. The cars which pass over street car curves in New York pass over them singly, for the most part, and are hauled by horses, although there are some very sharp curves operated by dummy engines.

For reasons given in part in the following article on friction it is a mistake to suppose that the curve resistance is inversely as the radius. For the reason that the slipping of wheel on rail takes place at a more rapid rate on very sharp curves it is almost if not quite certain that the curve resistance *per degree of curve* is materially less on sharp curves than easy ones, although the common impression is directly the contrary. Direct tests indicate this, and all the experimental evidence tends to show that minute increases in very low sliding velocities materially reduce the coefficient of friction with unlubricated surfaces, as they certainly do with lubricated surfaces. The same result appears to follow from passing over curves with a higher velocity, as was curiously shown on the Petersburg curve just mentioned. Running around it slowly there was great resistance and danger of mounting the rail; running around it at 8 or 10 miles an hour all this trouble disappeared. But in any case, the use of very sharp curves should be looked on only as an undesirable possibility and avoided if possible, especially if they are not so situated that the rails may be well greased and used only by cars in perfect order.

The announcement which appears in another column, announcing that the copies which remain of the admirable "History of the St. Louis Bridge," by Prof. C. M. Woodward, will be closed out at $12 a copy, affords an opportunity, which does not occur often, to obtain a very valuable and standard $40.00 work for less than one-third its price and worth, and we feel that it is but just to our readers as well as to the author, by whom it was prepared as a labor of love, to call especial attention to the opportunity. The book was a very costly one to prepare, and was necessarily sold at a high price, as it is very complete. It not only treats of the details of the bridge itself, but contains full records of nearly a thousand tests made during the construction of the bridge. It is not at all likely that it will take more that a week or two to clear out the entire remaining stock at the price named and we think every bridge engineer, not to speak of engineers generally, will regret it if he does not avail himself of the opportunity while it exists.

The Niagara Ship Canal.

We have received from the Oswego Board of Trade a map showing the location of the proposed Niagara ship canal, and the connecting waterways east and west, as prepared for the Board by Mr. Wm. Pierson Judson, M. Am. Soc. C. E., a civil engineer of long experience in the river, harbor and lake surveys of our Northern frontier. The projectors of this canal seek to bring deep-water traffic from the upper lakes, 146 miles nearer to New York than at present, by a ship canal around the Falls, and replacing Buffalo by Oswego as a point of entrance to the Erie canal, *via* the Oswego canal.

The charge is made that the Welland canal is not deep enough, with its 14 ft., to accommodate modern lake traffic, and that the tolls charged upon it are almost prohibitory. The new Niagara canal is proposed to take vessels of 19 ft. draft and 3,000 tons carrying capacity, with a saving in freight charges, as figured by Mr. Judson, of ¾ ct. per bushel, or $750 on one cargo of 100,000 bushels. The estimated cost of a 20 ft. canal, 25 miles long, is $18,000,000, or

$19,000,000 for an alternative line 18 miles long. A bill is now before Congress (H. R. 8,064) providing for this work.

There seems to be, commercially considered, little doubt that a ship canal of not less than 20 ft. depth around Niagara Falls would be a very proper and useful undertaking. Provisions are now being made to deepen the connection between Lakes Superior and Huron from 17 to 20 ft., and the St. Clair connection, between Lakes Huron and Erie, from 16 to 20 ft. With these channels improved there is certainly no good reason why we should interrupt the chain of our lake traffic at Niagara either by submitting to a foreign toll or by limiting it to a 14 ft. canal. At present the lake traffic would cease at the entrance to the St. Lawrence river for anything exceeding 9 ft. or later 14 ft. draft, as far as communication with the Atlantic in that direction is concerned.

But the Oswego Board of Trade, with the very laudable purpose of advancing the interests of that port, propose to stop the American traffic, at least, at their town, and by deepening the Oswego canal to the 9 ft. proposed for the Erie, tap the latter canal at Syracuse, and leave Buffalo, and the towns between that point and Syracuse, out in the cold as far as lake-canal traffic is concerned. What these towns will have to say upon this subject is outside of the present discussion; but if western shippers can save ¾ cts. per bushel, as promised by Mr. JUDSON, by keeping on with their steamers to Oswego, the promoters of the Niagara canal can find a substitute for Buffalo influence in support of their bill.

While the bill before Congress advocates a navigable channel between Lakes Erie and Ontario as advantageous for "ships of war" as well as merchant vessels, the military advantages of such a water way are rather secondary, unless water communications between Oswego and New York, or the upper Hudson, is made at least equal in depth of channel (14 ft. as proposed), to the Canadian canals leading to lake Erie. While neither the United States nor Canada takes the trouble to maintain more than a mere shadow of a navy on the lakes, Canada could send quite a fleet of light-draft gun-boats into these waters on short notice, provided that Canada was so disposed and the United States permitted such a disposition. But the contingency of war need hardly be much thought of. The interests of our neighbors are too nearly identical with our own, the relationship too close, and the matters at stake along our own frontier too important to lead us to expect any hostile demonstration from that direction, nor need we doubt our ability to check such a demonstration, in a very decisive manner, should a few sore-heads at Washington and London start a quarrel which would certainly not be welcomed nor permitted by either people, as a people.

The day is past for declaring war and fighting all within the same 24 hours; and it would be no difficult military trick to capture a canal just beyond our own frontier in an emergency. And as we believe neither Canada nor the United States are bothering themselves about the military aspect of their respective lake canals, the subject must rather be considered from a commercial standpoint. In this latter light a ship-canal around Niagara Falls, in connection with deeper channels between the upper lakes, would be very likely to benefit the lake traffic in decreasing canal transit, and would certainly benefit Oswego, or other ports on Lake Ontario, if they could be made the points of transhipment instead of Buffalo. The latter city, with its extensive and costly facilities for handling this trade, will very naturally and properly object, and the fight will come between the city that has it now and the one that hopes to secure it, *via* Niagara. This being the present condition of affairs we have little expectation of seeing the canal built around Niagara until the completion of the western connecting links and the pressure of western traffic shall make the shortening of the canal route a matter of greater importance than at present.

If the Oswego promoters would propose to utilize the money which should otherwise be expended in deepening the whole 352 miles of the Erie canal to 9 ft., in making the 206 miles from Oswego to the Hudson deeper still, or 14 ft. if possible, the canal end of the scheme would compare more favorably with the work the Canadians have in train along the St. Lawrence river, and communication between the lakes and the sea would be more nearly on an equal basis, as far as the two countries are concerned. The two projects should move together however, and that is not the case just now.

The Laws of Frictional Resistance.

It is one of the most extraordinary events in the history of science that from 1831 till about 1876 there was absolutely no attempt worth speaking of to enlarge our knowledge of the laws of friction, which during all that period was assumed to be complete, although it was really worse than nothing, since it was for the most part wholly false. In the year first mentioned, Gen. ARTHUR MORIN, then a Captain of Artillery, began a series of experiments which extended over two or three years, and which resulted in the enunciation of these three "fundamental laws of friction" no one of which is even approximately true:

1. The friction between two bodies is directly proportioned to the pressure; *i. e.*, the coefficient is constant for all pressures.
2. The coefficient and amount of friction, pressure being the same, is independent of the areas in contact.
3. The coefficient of friction is independent of velocity; although static friction (friction of rest) is greater than the friction of motion.

Perhaps the beautiful simplicity of these laws, which are comprehensible by the dullest mind, and only lack a foundation in fact to make them all that could be desired, helped to give them currency and to discourage all attempts to verify or extend them; but whether for that or other reason, such was the result. For more than fifty years they were accepted as axiomatic, and were quoted as such without question in every scientific work published during that whole period. Now that they are so thoroughly discredited it has been attempted to explain their defects away on the ground that they only cover a very limited range of pressures, areas, velocities, etc., and that MORIN himself only announced them as true within the range of his conditions, but the implication was that they were universally true, and it is now clearly established that there are no limits or conditions within which any one of them even approximates to exactitude, and that there are many conditions under which they lead to the wildest kind of error, while many of the constants were as inaccurate as the laws. For example, in MORIN'S "Table of Coefficients of Moving Friction of Smooth Plane Surfaces, perfectly lubricated," which may be found in hundreds of text-books now in use, the coefficient of wrought-iron on brass is given as .075 to .103, which would make the rolling friction of railway trains 15 to 20 lbs. per ton instead of the 3 to 6 lbs. which it actually is.

To Prof. R. H. THURSTON belongs properly the chief credit of overturning this mass of error, and bringing forward the true laws and true constants of friction in lubricated surfaces. Almost simultaneously MR. GEORGE WESTINGHOUSE, Jr., and Capt. DOUGLAS GALTON conducted their famous series of air brake tests in England which was and is the best existing evidence of the laws of friction of unlubricated surfaces. The first tests upon complete railway trains in which the now accepted fact was observed that the rolling friction of loaded cars was much less per ton than of empty cars, and that both were much lower than commonly supposed, were made by Mr. WELLINGTON in Cleveland, O., in the summer of 1878. The apparently extraordinary result that loaded cars should show a rolling friction somewhat less than 4 lbs. per ton and empty cars somewhat more than 6 lbs. per ton was there reached for the first time, the only outside evidence to support these then surprising but since established constants being the almost simultaneous tests of THURSTON and WESTINGHOUSE first referred to. It has since appeared that various dynamometer tests on the Pennsylvania Railroad, then unpublished, had shown very similar results, and a great number of tests made since have likewise done so.

These "controversions of established facts" (MORIN'S laws) were somewhat slow in finding general acceptance, especially abroad. Finally however, in 1883-4, Mr. BEAUCHAMP TOWER made a series of extensive and remarkable experiments under the auspices of the Institution of Mechanical Engineers, and Mr. WM. STROUDLEY has also made some important experiments, all of which, with some important tests of his own, are admirably summarized by Mr. JOHN GOODMAN, then a Student and now an Associate Member of the Institution of Civil Engineers, in the paper which we are now publishing. The most interesting part of this paper, as respects lubricated surfaces, has yet to appear in a series of comparative diagrams showing at a glance just what results have been obtained under varying conditions. It has been a common error of experimentors to neglect to prepare such diagrams, but to content themselves merely with the presentation of tables, which latter are exceedingly difficult to interpret correctly even with the utmost care, and impossible to interpret with any approach to exactness without such care, and a pretty sound general knowledge of the subject in addition.

We postpone all comments on the question of friction with lubricated surfaces until we publish the matter referred to. The friction of unlubricated surfaces has been far less carefully determined by experiment, and hence is still involved in much greater uncertainty, which is the more to be regretted as it is in some respects an extremely important field of investigation. We regret to say likewise that in this field Mr. GOODMAN'S summary of the laws indicated by such tests as have been made is open to much the most serious objection. This summary is as follows:

1. The friction between dry surfaces under moderate loads and low velocities varies directly as the normal pressure between them.
2. The normal pressure remaining unchanged, the friction is independent of the areas in contact.
3. It is always greater on the reversal of the direction of sliding.
4. It sensibly diminishes with the rise of temperature.

The first of these laws, although carefully limited to "moderate loads and low velocities" is probably not true even for them, and is certainly not true for extremes of loads either

way. The strongest practical proof of this, as to high pressures, is the well known higher co-efficient of adhesion of locomotives when the drivers are heavily loaded. The old light engines of earlier days had an adhesion of only 1-11 to 1-7. Modern engines have an adhesion of 1-3 and over, although the lighter cars had in the GALTON-WESTINGHOUSE experiments an adhesion of only 1-4. This, to be sure, is static friction, but RENNIE's experiments, old but quite extensive and good and still to be found in all the pocket-books, indicate positively that the coefficient regularly and largely increases as the pressure rises from 32½ to 821 lbs. per sq. in., and there is nothing in later tests to discredit or throw doubt on this. On the other hand, as respects very light pressures, an experiment by the present writer, too trifling to have been heretofore published, but decisive so far as it went, indicates an equal irregularity here, in the opposite direction. Taking a piece of thin boiler iron on a planed but not polished iron slab, and comparing it with the friction of a cubical block of the same weight and quality of surface it was found the larger area gave a very much greater coefficient; about three times as great. This small test is not mentioned as decisive, for two or three tests of that kind never can be, but as the truth of a mathematical equation is best tested by extreme values, so it is highly important in experiments of this kind to provide a sufficient range between the extremes tested, and the range has been so small in many tests as to only need a slight variation of conditions or moderate errors of observation to obscure the truth completely.

The second law above quoted, that the total friction is independent of the area, the total pressure remaining constant, is a mere variation of the first, and is open to the same objections and limitations. It appears to be taken directly from a very guarded expression by Capt. GALTON, that he was "not prepared to say" that his tests showed any difference with brake-shoes having parts cut away so as to expose only a series of square faces of one-third the total area of the original shoe. It is a well-known and well-proved fact, however, that brake-shoes only partly worn to the wheel have very much less retarding effect than brake-shoes completely worn to it, and this well established fact should justly outweigh Capt. GALTON's few and dubious records. Again, such a fact as that last mentioned contradicts the RENNIE tests, since the latter necessarily indicated that the less area should give a higher coefficient, by increasing the pressure per square inch, and striking an average between the two we have a *quasi* indication that the coefficient is independent of area. But striking an average in such matters is a very improper process, and by far the safer conclusion from such apparent contradictions is that there is no absolute "law" about it, but that under certain conditions the coefficient increases with the areas in contact, and under others decreases. Considering friction as due to the engagement of and detrusion of minute, tooth-like projections from the surfaces in contact, we can see why this should be so. The pressures being always sufficient to fully engage these projections, the more of them there are engaged the greater will be the resistance to motion. The pressures *not* being sufficient to fully engage them (which will largely depend on speed) an increase of unit pressure will increase the coefficient by causing detrusion of teeth which before hardly engaged at all. Between these two there is room for almost infinite gradations of conditions, and for as infinite variations in the apparent "laws of friction." As we shall see is the case with lubricated friction, it is as yet only safe to conclude that there is no positive and invariable simple law in this matter, and this conclusion will probably become more certain with time.

The third law, as to reversion of direction of motion increasing friction, is undoubtedly correct and obtains also with lubricated surfaces, as was first observed by Mr. BEAUCHAMP TOWER.

The fourth law, that unlubricated friction diminishes with rise of temperature, we know of no positive evidence to support. It appears to be a deduction from the great loss of brake efficiency with time of contact, as first determined in the WESTINGHOUSE-GALTON tests. Such contact is of course accompanied by rise of temperature, but the variation is far more likely to be due to effect of disintegrated particles of the surfaces in contact acting as balls to reduce friction than to the rise of temperature, and it was distinctly ascribed to this cause by Capt. GALTON himself.

The most important and the best determined of all the laws of unlubricated friction is not touched on at all in the above summary, and may be thus expressed :

The coefficient of unlubricated friction decreases materially with velocity, is very much greater at minute velocities of 0 +, falls very rapidly with minute increases of such velocities , and continues to fall much less rapidly with higher velocities up to a certain varying point, if not invariably under fair and equal conditions, following closely in all these respects the laws which universally obtain with lubricated friction.

This law is far more certain and more nearly invariable than any other in friction, since it holds also, in identical words, with the friction of lubricated surfaces. It leads necessarily to some important practical conclusions and deductions. It is to be regretted, therefore, that it should ever be left out in summaries of the laws of friction.

A Question of Sewer Assessments.

A decision has recently been given by Chief Justice PARK and Judge CARPENTER, regarding the liability of certain property owners at New London, Conn., to assessment for the cost of sewers, which is of more than local interest. Certain parties appealed from the assessment made by the Board of Sewer Committee on a number of grounds, all of which were objected to by the Court. The one of general interest was, that the Board were governed by a rule established by themselves, in assessing benefits strictly and solely in proportion to the width and area of the lots fronting said sewer. The rule adopted by the Board with the approval of the Common Council was to assess 50 cts. per ft. of street frontage and seven mills per square foot area of land benefitted, not exceeding more than 100 ft. from street line, with certain modifications in corner lots and in very irregularly shaped lots. In the application of the rule no regard was had to the value of different lots nor to the value of building or other improvements thereon. While the court rules that there is no act which specifically authorizes this method of assessment, yet it maintains that the only limitation in the act is that the assessment shall be just and equitable. Any rule is allowable which accomplishes that result and the only question is whether the rule adopted works any substantial injustice. The court found that the assessment was not only "fair and just" but that the benefits to the property in each and every case were greater than the cost and reassesses each appellant to that amount together with $8 costs against each. The following extract from the decision will be of interest probably, to many having to do with works of this nature:

"The principal complaint is that land in the suburbs which is worth much less per foot front than land in the central portions of the town is charged at the same rate.

"It must be borne in mind that this is not an ordinary tax which, in theory, is a percentage of what a man has, but is a proceeding to recover from proprietors of land some portion of the benefits conferred upon such land by a public improvement for the purpose of defraying the expense of such improvement. It has not been made to appear that the benefits conferred, or the cost of constructing the sewer, bear any proportion to the value of land or the value of the improvement thereon.

"The following considerations will aid us in estimating approximately the benefits of a public sewer. In the first place we must premise that in a place like New London a sewer or a system of sewers is a necessity. Individuals cannot either alone or in combination with others conduct their own sewage matter to the harbor or coves. Sanitary reasons forbid it. The experiment has been tried by some of the appellants and the result is an intolerable nuisance. Cess-pools may be allowable to some extent in the suburbs but they are objectionable, and in the thickly settled portions of the town are wholly inadmissible. Assuming then that a sewer is absolutely necessary, and that each individual may choose between the use of a public sewer, and constructing a private one, it then becomes a question of comparative expense.

"How much will it cost a man to procure a right of way and construct a sewer that will discharge its contents into deep water? And how much expense will it be from year to year to keep it in repair? The idea readily suggests itself to the mind that there might be a large saving by several combining and using one sewer.

"That is undoubtedly so; and every business man would at once follow the suggestion to the logical conclusion that one sewer or system of sewers for the accommodation of all would be cheapest and best for all concerned. Obviously no one of these appellants could procure sewerage facilities for the sum assessed against him, to say nothing of the expense of repairs from year to year. These suggestions ought to be sufficient to satisfy every intelligent man not only that a public sewer properly constructed, and permanently cared for, is cheaper and better than any other, but also that it benefits property to an amount largely in excess of the cost.

"The benefit however, is not in proportion to its value, but is a given sum irrespective of its previous value or of the value of the improvements thereon added to the real worth of the land. It matters not whether the land is improved or unimproved. That is a matter that cannot well be taken into consideration. A lot is occupied to-day; to-morrow a fire may sweep away the buildings and the owner will have no present use for a sewer. A lot is vacant now, but at anytime a building may be constructed thereon and a sewer becomes a necessity. In either case the sewer is an improvement that adds so much to the value of the land in market. Temporary considerations do not affect the value of the land as such and ought not to affect the amount of benefits assessed.

"Moreover the cost of constructing a sewer is not affected by the use or non-use of the land. It costs as much to construct a sewer for vacant land as for land covered with buildings.

"The cost depends in some measure upon its length, and its length has some relation to the aggregate of land fronting thereon. The benefit conferred is largely in proportion to the quantity of land as shown by its superficial area. On the whole the rule seems to be a just and reasonable one: and it is not claimed that it was unfairly or partially administered. All in similar circumstances fared alike."

PERSONAL.

D. MCN. STAUFFER sailed on March 31, on the steamer *La Bretagne*, for a vacation trip of three or four months in Italy and southern Europe. He expects to return early in July.

H. H. FILLEY, late Chief Engineer of the Mexican National Railway, and who has lately opened an office at Kansas City, has been engaged to return to Mexico to make some examinations for the lateral system of the same road, and to revise some of the lines already run, a work which will be likely to occupy him a couple of months.

WM. R. BILLINGS has resigned his position as Clerk and Superintendent of the Taunton, Mass., water-works, and enters the employ of the Chapman Valve Mfg. Co., of Indian Orchard, Mass. Until further notice Mr. BILLINGS' personal address will be No. 15 Harrison St., Taunton.

The Moving of the Brighton Beach Hotel at Coney Island.

For some years the large summer hotel at Brighton Beach has been threatened by the encroaching of the sea. The water front of the hotel was originally 700 ft. inland, but this distance was lessened until the waves rolled beneath the hotel, overturned the supporting piers, and broke down the foundation wall of the land front. The gain of the sea upon the land was 150 ft. during last year.

To save the hotel it was decided to move it directly forward 595 ft., and as the building is 460 ft. long by 130 ft. deep, from two to five stories high, has five towers, and is estimated to weigh 4,500, tons this was a considerable undertaking. To accomplish this, the building was raised on jack-screws, 1,200 piles were driven in the sand beneath it, and 24 evenly spaced railway tracks carefully laid upon them and extended inland. This done, 112 platform cars, made especially for such purposes, were placed beneath the hotel, and long timbers, were stretched from car to car, and the building let down. These long timbers so distributed the weight of the building that the 112 cars practically acted as one, while they carried an average weight of about 40 tons. On the first day of the moving, the building was hauled forward 114½ ft. To do this, 6 engines were used, three each on two tracks near the center of the building. Attachments were made between the engines and the front car on each of the 24 tracks by means of ropes, pulleys and snatch-blocks so that the forces applied to each point were perpendicular to the building, and parallel. Cables from each engine were attached along the whole length of the building, thus ensuring a uniform haul for each end.

At the present writing, the building has been moved 264 ft., as far as is possible until the track is extended further to the front. On the second day, but 4 engines were used, and they are said to have made a pull of 57 ft. at the rate of 8 miles an hour. The average pull has been about 50 ft., a rearrangement of the tackle being necessary after this distance had been traversed. The last move of 50 ft. was effected by four engines, and the building moved forward evenly and silently. When the engines were stopped, the building immediately come to a standstill without brakes being used on the supporting cars.

The operation has been eminently successful in every respect. It has been under the direct supervision of Supt. J. L. MORROW of the Brooklyn, Flatbush & Coney Island R. R. Co., the owners of the hotel. The labor contract for blocking up the hotel was given to B. C. MILLER, a contractor and house-mover.

It is an interesting fact that the brick piers which originally supported the hotel had been tipped bodily to an angle of 30 degrees by the incoming sea and remained intact, without cracking at all.

The Registration of Civil Engineers.

An extraordinary bill is now pending before the English Parliament for the registration of all civil engineers and architects, for the protection of the public against incompetent practitioners. From a long and vigorously antagonistic editorial which appears in *Engineering*, we make the following extract, sufficiently showing the scope of the bill, which we presume has little chance of passing. After pointing out that there is no demand from engineers or others for such a bill, *Engineering* says:

"We can point with proud confidence to the work which has been done, and the men who have been reared under the existing system, and can affirm that no system that was not based on the freedom of every man to follow the bent of his own genius would have raised England to the position she occupies in the world. Wherever we go we find the work of English engineers. Railways, docks, harbors, water-works, and canals in all parts of the globe are the evidence and witnesses of this satisfactory result of the system in the past, and if more be wanted we can point to the great army of foreign engineers who have laid the foundation of their knowledge in a study of British practice, and who are still alive to every improvement that we effect. If a lusty youth and a noble manhood be proof of a sound constitution, the engineering profession of this country can fairly claim exemption from all measures directed to improve its condition. After having grown up without legislative care and pampering, and become the greatest power for the spread of civilization, it is rather late for a set of old women to take it in hand and commence its nurture with some fanciful variety of feeding stuff.

"It may interest our readers to know the means by which the capable engineer is to be distinguished from the pretender. A general council is to be formed of five members nominated by the Privy Council, five elected directly by the profession, and sixteen nominated by as many societies and bodies, of which seven are universities. The council is to appoint a registrar, who will receive and enter the names of all persons already in practice, either for themselves or as assistants, for a fee varying from £3 to £5, and he will renew their names annually for a fee of 10s. Any unregistered person who shall use the name or title of architect civil engineer, or surveyor, will be liable to a penalty of £20 for the first offence, and £50 for a subsequent offence. Future engineers are to be admitted by examination conducted by institutions and universities under the supervision of the council. They likewise will have to pay fees on various occasions.

One scarcely knows which is the greater, the ignorance or the conceit of the persons responsible for this Bill. It is perfectly evident that they have no idea that a far more perfect machinery than that they propose for the protection of the public a ready exists. They must have heard of the Institution of Civil Engineers, for they mention it in the Bill, and they graciously provide that its charter shall remain in full force "except so far as it is inconsistent with this Act." But they do not appear to understand that membership or associate membership of the Institution is a guarantee of knowledge and ability of far more value than the diploma they propose to give to those who have passed an examination. That the former implies that the holder has won his spurs by carrying out important works on his own initiative, while the latter is proof of a systematic technical training carried on up to the age of twenty-six at least, and of the personal appreciation of five other members of the Institution.

"There are very few scenes of British enterprise of any importance where a corporate member of the Institution of Civil Engineers cannot be found, and any one in want of engineering assistance and who does not feel able to make a proper selection among the many capable men outside of the ranks of the Institution, may apply to him with the certainty that he is neither a novice nor an imposter. He may not have special skill in the particular matter in hand, but his education will have rendered him far better able to tackle a new subject than if his early years had been spent in cramming for an examination, and neglecting the broader and more practical lessons of his calling. The world is overrun with examinations already, but so long as we can raise our voice we shall not cease to protest against one being placed across the entrance to engineering. We can learn what its effects would be by seeing how it would have worked in the past. A qualifying examination would have shut the gate against BRINDLEY, STEPHENSON, NASMYTH, WHITWORTH, FAIRBAIRN, and a host of men whose names are a glory to the country, and we fail to see that it would have had a single countervailing advantage."

A "Constant Underground Traveler" sends a long communication to *Herapath's Railway Journal*, complaining bitterly of the ventilation of the Metropolitan District Railway, and declaring that "after years of observation on this subject, I am convinced that it is in a direction of improved ventilation alone, that they will find a solution of their financial difficulties." There has been much said of late in regard to the use of the London underground railways, being a "disgusting necessity," and it certainly seems as if, except for such a special cause, no London underground lines should be in financial difficulties. Certainly it is clear that to "fill the bill" well, underground locomotives must not discharge their steam and smoke into the tunnel, nor is it a necessity for them to do so even in the present state of the arts, without further inventions, although there is doubtless room for considerable improvement from an economic point of view.

A COLLISION, for which there seems little excuse, occurred on the Michigan Central, at the Chicago Grand Crossing, on the evening of March 27. The rear sleeper on an express train was entirely demolished, and a number of passengers injured, by a freight train on the Wabash & Western Ind., running into it, in spite of the fact that the crossing gates were down with signal lights displayed.

There could be no better illustration of the utter hopelessness of safety by reliance on mere human vigilance, since at this point the country is flat, the grade level, the road straight and the weather was clear. Had interlocking and derailing switches been in use, the accident could not have occurred. Besides injuring five passengers by the sleeper colliding with the engine, four or five freight cars were wrecked.

THE long and honorable record of the bridge department of the Chicago, Milwaukee & St. Paul has been broken by a serious disaster. A trestle near New Hampton, Ia., failed April 5, and 9 lives or more were lost, and 25 or 30 were injured. The engine and three cars plunged into the swollen stream, one car, the smoker, being almost entirely submerged.

The fault, if fault there be, seems to lie with the track walkers and not with the structure, so that the fine system of inspection of structures on that road is in no way discredited. Flood and ice together must at times be too much for any structure.

THE Bush Interlocking Bolt Co. has just made a contract for 46,000 pairs of its interlocking bolts, for use on 64 miles of new 80 lb. rail track, on the New York Central & Hudson River Railroad which has already some 25,000 of them in use. A new joint is to be used in connection with them, of which we shall publish an engraving next week. We are informed that within the past six months, upward of 100,000 pairs of these bolts have been sold to various companies, not including the above order.

PLANS have recently been prepared for four overcrossings at the town of Westbrook, Conn., at a total estimate cost of $33,510 of which $3,400 to $3,800 was assessed on the town. The town is now making a vigorous effort to escape from this, on one ground and another, after having once voted in town meeting in favor of the plans. The decision is to be rendered about April 16, but Westbrook will not probably get a great deal of sympathy, if it is compelled to foot the bills.

PUBLICATIONS RECEIVED.

Carharts' Plane Surveying.

Western University of Pa.
ALLEGHENY, Pa., March 27, 1888.

EDITOR ENGINEERING NEWS:

I beg to call attention to a misstatement in the last issue of the NEWS concerning my surveying book. Among other things it is said there that it "will undoubtedly prove useful in academies and classical institutions when the time devoted to the subject is only sufficient to allow a thorough course in compass surveying with a brief smattering of other methods. The magnetic compass is now mostly a thing of the past, and yet nearly 300 pages are devoted to it in this treatise."

The statement is, that here is a book devoting three-fourths of its pages to a method of surveying that is *antiquated*, and only giving a brief *smattering* of other methods—as transit surveying—which are at present employed! The fact is, the caption of Chapter II is "Compass and Transit Surveying," so chosen because, as any practical engineer knows, there is much that is common to both compass and transit work, in recording notes, in determining latitudes and departures, in making plots, calculating areas, etc. It is simply a matter of convenience to writer and reader.

Any one who will glance over the book will not fail to see that the 200 pages—computed 300 by the reviewer and credited to compass surveying—are mostly devoted to transit work, that the numerous and varied examples and field exercises proposed in these pages apply to *transit surveying*, and that if the book has any merit, it is that it gives a thorough course in compass *and transit* surveying. Furthermore it is not right to leave the inference that in the 60 pages on city surveying a person can get only a *smattering* of the subject. There is no other surveying book which treats it more thoroughly. The same is true of the chapter on chain surveying. A copy of the book was sent to ENGINEERING NEWS believing that a *careful* examination and *impartial* review would result. It is still hoped that the corrections indicated will be made: justice requires this. Say nothing, if you desire, concerning what is treated in other chapters, but let facts be given on those parts selected for review. The undersigned will then not complain, nor will he have much anxiety regarding the position which the publication may take among works on kindred topics. Respectfully submitted,

D. CARHART.

[We are glad to make the correction desired by Prof. CARHART that the title of Chapter II. is "Compass and Transit Surveying." This chapter gives a full description of the transit and its adjustments, taken from Gurley's Manual, and also a number of examples and problems relating to its use. The general character of this chapter, however, is the same as that given in most text-books under the title of compass surveying. The area of a field may be found by chaining the sides, measuring the angles with a transit, deducing the bearings of the sides from these angles, and then computing the latitudes, longitudes, double meridian distances, north areas and south areas. If this is transit surveying it is certainly very fully treated in

the book, which also gives an excellent transverse table to assist in the computations. We conceive that a chapter on transit surveying should explain the reasons for the adjustments of the instrument, the reason why eccentricity errors are eliminated by reading both verniers, the method of surveying and plotting a tract of land by basing the work on a triangulation, and the methods of locating contours. The book treats of none of these points; indeed we have been unable to find in it the word triangulation except in connection with the simple problem of determining the distance across a pond or river by the use of a triangle. In our estimate of 300 pages were included the chapter above mentioned, the chapter on chain surveying which relates largely to the determination of areas by offsets and by division of the figure into triangles, the chapter on the declination of the magnetic needle, that on laying out and dividing land, and that on the surveys of the public lands. These five chapters embrace 312 pages. The remaining chapters are: 13 pages on plane table surveying, 54 pages on city surveying, 17 pages on mining surveying, and 15 pages of appendix containing Judge COOLEY's paper on the judicial functions of surveyors. The chapter on city surveying is good, as far as it goes, but fully one-half of it is devoted to the description of leveling instruments and rods, their adjustments and the method of keeping level notes.—ED. ENG. NEWS].

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The regular monthly meeting was held at the Society's house, New York, April 4; President THOS. A. KEEFER in the chair. The Secretary announced the deaths of CHARLES LATIMER, Member; WM. A. G. EMONTS, Junior; and GEO. W. CASS, Associate. J. FOSTER FLAGG read, as a continuation of the discussion on the flow of sap in trees which was begun at the last meeting, extracts from authorities to prove that sap accumulates in sugar maples in the all ready for the flow in the spring.

R. K. WRIGHT, Jr., C. E., formerly connected with the engineer corps of the Panama Canal, made some very interesting remarks in an informal manner, as to the canal and as to his experience on the works. He stated that the total excavation for the original project for a sea level canal is 153,000,000 cu. metres, and the total for the "temporary" lock project is 105,000,000 cu. metres, of which amount only 32,000,000 cu. metres, had been excavated by January 1, 1888. The proper management of the work is interfered with by the fact that the Director General at Panama is largely controlled by a committee in Paris, many of the members of which have never visited the Isthmus and are unacquainted with the requirements. He doubted if M. DE LESSEPS himself really knows the actual condition of affairs at the canal. There was also much delay and inconvenience caused to the conduct of the work by want of harmony in the administration, and by the excessive red tapeism of the management. All requisitions had to be signed by the Director General at Panama, and on one occasion the dredges on Mr. WRIGHT's section were stopped 4 days for want of oil for the machinery, although there were 16 barrels in the store, but the storekeeper could not deliver them without an order from the Director General; this requisition passed through the hands of numerous officials before getting the final signature, and it took 16 days to get the oil. The delays caused by such arrangements, however, eventually resulted in some improvements. Up to 1885 no contracts were let by bids, but by private arrangement, the cost of the work being consequently very extravagant. The contract for cutting down and removing trees along the route was let at $260 ($1 = 72 cts.) per hectare (2½ acres), and was sublet at $80, $60 and $50, the work being finally done at the latter price; the contract for removing the stumps was let to the same man at practically the same price and was again sublet, the final price being $60. The work was not started in a proper manner, operations were started at so many points that the Panama Railroad could not give the necessary service, and material could not be forwarded without great delay. The success of the canal is said to depend on controlling the Chagres river and making the Culebra cut. Plenty of water for the summit level locks can be obtained by building the Gamboa dam.

Mr. APPLETON, who is connected with the canal, and was a member of the Convention of 1879, read a paper speaking of the project in very bright colored terms, and made some very sanguine remarks as to the early opening of the canal and the completion to tide level while in operation; the revenue being used for this completion. He stated that the company has plenty of money to last till next fall, by which time M. DE LESSEPS will have succeeded in raising funds to complete the work. He scouted the idea of France abandoning the scheme, or of French investors being ruined; the number of investors was stated to be at least 400,000. He thought that America had not been forward enough in aiding the enterprise, and urged that American investors should take more financial interest in the next issue of bonds; it would be better, he thought, for all the energy to be devoted to this one work instead of dividing it between the Nicaragua canal, Tehuantepec ship railway, etc. THEODORE COOPER, M. Am. Soc. C. E., suggested, however, that Americans, as a practical people, had naturally held aloof from a work conducted on such methods as the Panama canal. Mr. APPLETON put the present par value of the bonds at $300,000,000 or $400,000,000, total paid in $200,000,000, but stated that this amount was not excessive, as many of the bonds would not mature for 75 years, by which time the canal would be earning plenty of money. The Panama Railroad was bought for $200,000. For descriptions of the proposed locks he referred to ENGINEERING NEWS, March 10. The next loan of $120,000,000 will cover the total cost of the completion of the canal with locks, and the revenue will be sufficient for completing it to sea level.

Other gentlemen connected with the canal company made some remarks, and some of the comments on Mr. WRIGHT's statements were not remarkable for good taste. The result of the meeting would hardly tend to make engineers or investors enthusiastic in favor of the enterprise. Of course the work is possible, but whether it is practicable is another matter.

The following were declared elected:

Members: WILLIAM CRULMAN AMBROSE, Div. Roadmaster, Southern Pacific Ry., Tulare, Cal.

FRANCIS WEBSTER BLACKFORD, Jr., Res. Eng., Union Pacific Ry., Butte, Mont.

HOWARD BREEN, Keystone Bridge Co., Pittsburg, Pa.

EDWARD CARLOS CARTER, Prin. Asst. Eng., Chicago & Northwestern Ry., Chicago, Ill.

JOHN JOSEPH DONOVAN, Eng. in charge of branches of Northern Pacific R. R., Helena, Mont.

FRANK LOUIS FULLER, Eng. of Marblehead waterworks, Boston, Mass.

BRUCE F. HOUSE, Div. Eng., Denver & Santa Fé Ry., Denver, Col.

JAMES MACFARLANE, Anaconda Mining & Smelting Co., Anaconda, Mont.

CHARLES CLEMONS ROSE, Div. Eng., Delaware, Lackawanna & Western R. R. Scranton, Pa.

HORACE EDWARD STEVENS, engineer and contractor, St. Paul, Minn.

CHARLES FREDERICK STOWELL, Bridge Engineer for the New York State Board of Railroad Commissioners, Albany, N. Y.

ARTHUR NEWELL TALBOT, Asst. Prof. of Mathematics and Engineering, University of Illinois, Champaign, Ill.

CHARLES CHANCELLOR WENTWORTH, Prin. Asst. Eng., Construction Dept., Norfolk & Western R. R., Roanoke, Va.

Associate: GEORGE HENRY CRAFTS, engineer and contractor, Atlanta, Ga.

Juniors: WILLIAM GEORGE CLARK, 1st Asst. Eng., City Engineer's office, Toledo, O.

ARTHUR LELAND CORNELL, Asst. Eng. for Brown, Howard & Co., New Croton Aqeduct, Tarrytown, N. Y.

EDWARD BERTON KENT, Chicago, Milwaukee & St. Paul Ry., Milwaukee, Wis.

WILLIAM WILLIS PENNEY, Asst. Eng., St. Louis Water-Works, St. Louis, Mo.

LOUIS LINCOLN TRIBUS, Bienville Water Supply Co., Mobile, Ala.

HARRY R. WHEELER, Asst. Eng. Div. 1, New Croton Aqueduct, Sing Sing, N. Y.

American Water-Works Association.—The Eighth Annual Meeting will be held at Cleveland, O., on April 17, 18, 19. The headquarters will be at the Hollenden Hotel; rates $3 per day. Particulars can be obtained of H. F. DUNHAM, C. E., City Hall, Cleveland, O., who is the Chairman of the Local Committee of Arrangements. There will be a display of drawings, models, samples, etc. The following is the programme, but in addition to the papers on the list, volunteer papers are promised, and there will be ample opportunity for the reception and discussion of practical questions.—April 17, Morning Session, regular order of business. Afternoon session, "Sanitary Protection of Water Supply of Rochester, N. Y." J. NELSON TUBBS; "Use of Salt Glazed Vitrified Pipe," S. E. BABCOCK; "Consumption of Water by Cities and Towns." H. W. AYRES; "Water Supply of Tokio, Japan." Y. NAKAJIMA.—April 18, Morning Session; "Quindaro Settling Basins and Siphon Well," R. C. PEARSONS; "Reservoirs," S. MCELROY; "Water-Works Records," J. M. DIVER; "Weight and Thickness of Cast-iron Pipe," J. W. HILL. Afternoon Session; "One Phase of the Problem," H. F. DUNHAM; "Indirect Income of Water Suppliers," F. L. FULLER; "Feed Water Heaters and Condensers," C. A. HAGUE; "Stand-Pipes for Water-Works," B. F. STEPHENS. Evening Session; Volunteer papers, question box.—April 19, Morning session; "Recent Filtration Practice in India," S. TOMLINSON; "Practical Results in Mechanical Filtration," W. G. RICHARDS; "Liquid and Gaseous Fuels," H. H. HARRISON; "Approximate Determination of the Rental Values of Fire Hydrants," J. NELSON TUBBS. Afternoon session; regular order of business. President, J. T. FANNING, Minneapolis, Minn.; Secretary, J. H. DECKER, Hannibal, Mo.

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

Boston, Concord & Montreal.—This company has filed a bill in equity asking that the lease of the road to the Boston & Maine company be annulled and a receiver appointed.

New York & Massachusetts.—At the hearing at Poughkeepsie before Judge BARNARD, HENRY D. CONE, the chief owner of the road, testified that he has formed a combination with the Poughkeepsie & Delaware Valley Railroad, the Ontario & Western, and the Lehigh & Hudson to make an all rail route for coal and freight and passengers from the west and southwest into New England. ELBERT KEITH, C. E., testified that the New York & Massachusetts is to be extended 70 miles into Berkshire county, Mass., at a cost of $30,000 a mile.

Boston & Maine.—The bill permitting the consolidation of the Eastern Ry Company with the Boston & Maine has passed the Massachusetts Senate.

Lehigh Coal & Navigation Co.—A line is to be surveyed from Phillipsburgh to Belvidere, N. J. to secure a direct connection with the projected new lines to the Poughkeepsie bridge.

Grand Trunk.—The bill to permit the company to consolidate its bonded debt is under consideration by the Dominion Parliament. The company is to rebuild the wharf and freight shed at Portland, Me. this season. There will be about 1,700 new piles to be driven.

Western New York & Pennsylvania.—General Manager MERCHANT states that the proposed extension from Howard Junction to Clarion Junction, Pa. is not likely to be built this season.

Chicago & Canada Southern.—This Michigan road originally started as an extension of the Canada Southern, but operated for several years by the Lake Shore & Michigan Southern, is to be sold at foreclosure sale on August 8. The line is 67 miles in length.

Pennsylvania.—A section of new line, about a half mile in length, is to be built between Moss Side and Wall's stations, on the main line east near Greensburg. The new line will be double track and is to be finished within 6 months.

Rockaway Valley.—This line is to run from White House, N. J., to New Germantown.

New Projects and Surveys.

Collingwood & Bay of Quinte.—This Canadian enterprise, receiving attention from the citizens of Brighton, Ont., the proposed terminus. T. D. WELLS, of Brighton, is interested.

Belmont & Tilton.—This short road in New Hampshire will probably be built this season. EDWIN C. BEAN, of Belmont, is Secretary. The line is intended principally for lumber traffic.

SOUTHERN

Existing Roads

Louisville Southern.—Tracklaying is completed from Louisville south, 27 miles, and from Harrodsburg north 13 miles. A correspondent writes us that the "Danville" company whose incorporation was noted in our issue of March 24 has no existence in fact. The report grew out of the fact that a bill was passed by the Kentucky legislature permitting the Louisville Southern to extend from the terminus at Harrodsburg to Danville, a piece of work which will doubtless be put through this season. If we are rightly informed, the various extensions of the Louisville Southern are chartered under separate names as the "Danville," the "Woodford," the "Richmond, Irvine & Beattyville," etc., this probably on account of some technicality in the railroad statutes of Kentucky. It was this that caused the item to be classified as a "new project" instead of under its proper head, an extension of an "existing road."

Nashville, Chattanooga & St. Louis.—At the recent meeting of the stockholders of this company the purchase of the Duck River Valley narrow gauge road was authorized and also the issuance of bonds to meet the expense of changing the gauge. The road is 48 miles in length. It was also decided to refund the bonded debt by the issue of $20,000,000 of 5 per cent. bonds.

Tennessee Midland.—The tracklaying is completed from Jackson to Whiteville, and the line is expected to be open for traffic from Jackson to Memphis by May 1.

Louisville, New Orleans & Texas.—A ferry transfer and approaches are to be built on the west bank of the Mississippi river, at Helena, Ark., at a cost of $125,000.

Georgia Pacific.—At a mass meeting at Greenville, Miss., resolutions were passed favoring the granting of $25,000 for terminal facilities and right of way for this company. The active work on the extension will probably be delayed to await the outcome of the present fight in the Richmond Terminal Company. The refunding of the bonded indebtedness of the Georgia Pacific is likely to be satisfactorily arranged and altogether the prospects for early work on the extension seem very good.

Columbus Southern.—Grading is near completion on the line between Dawson and Albany, Ga., and it is thought that the line can be finished and opened for business by July 1.

Georgia Southern & Florida.—The surveys on this line have been completed from Valdosta, Ga., to Palatka, Fla., 135 miles. The line runs *via* Jasper, White Springs, Lake Butler and Hampton.

Atlanta & Florida.—About 60 miles of track are now down from Atlanta south and four daily trains are running between Atlanta and Zebulon, 52 miles.

East Tennessee, Virginia & Georgia.—The company is to spend $150,000 in enlarging its docks, terminal facilities, and warehouses at Brunswick, Ga.

New Projects and Surveys.

Virginia, North Carolina, Tennessee & Western.—A press report from Nashville, Tenn., states that THOMAS BEEN, the President of this company is "making an examination of Nashville, familiarizing himself with the lay of the country, and taking the preliminary steps toward securing a charter for his road." The route of the projected line is outlined from Portsmouth, Va., to Columbus, Ky., on the Mississippi river, about 750 miles. "In anticipation of the heavy business a double track will be constructed. It is designed to construct the road with no sharp curves, fast time being an especial object; and it is eventually proposed to extend it westward to San Diego, Cal." There seems to be nothing small about this enterprise, and we are only surprised that "President BEEN" didn't assure the credulous reporter that "ample funds had been secured by a foreign syndicate for building the whole line this season." This project we hang on the peg with the Pensacola & Puget Sound Diagonal Trunk Line, the American Central Railway and a few other monstrosities.

Cincinnati & Birmingham.—A subscription of $62,000 to this company, by Overton county, Tenn., has been defeated. At the recent meeting of the company, M. R. CAMBELL, of Tullahoma, was elected President, and W. C. MORGAN, of Fayetteville, Treasurer.

Carolina, Cumberland & Chicago.—It is reported that the grading is nearly completed on this road between Aiken and Edgefield, S. C.

Eastern, Barnwell & Western.—This enterprise, whose headquarters are at Barnwell, S. C., seems to have taken the form of an extension of the Blackville & Barnwell railroad to Savannah, Ga. A meeting was recently held at Barnwell and GEO. H. BATES and others were appointed a committee to secure aid for the enterprise.

Gulf & Chicago.—A press report from Springfield, Ill., says: "The officers of the proposed New Orleans & Chicago Railroad have completed arrangements for the survey of the line beginning at Effingham and running directly south to the Ohio river, opposite Paducah, Ky. The distance is 150 miles. The survey will begin April 9, and work on the grade about June 15."

Halifax & Indian River.—Incorporated in Florida by U. J. WHITE of Ormond, SAMUEL B. CARTER of Jacksonville and others.

Jacksonville & St. Augustine.—Chartered in Florida by N. F. Sylvester of Jacksonville and others.

Kentucky.—The following companies have been incorporated by the Legislature: The Smithland, Erin & Decatur Railroad Co.; the Kentucky & Missouri Bridge Co.; the Owensboro & Rockport Railroad Co.; the Belleview & Cincinnati Tunnel and Bridge Co., to build a bridge across or a tunnel under the Ohio River, with W. A. GOODMAN and others as incorporators; the Frankfort & Lawrenceburg Railroad Co.; the Owensboro, West Louisville and Sabre City Railroad Co.; and the Bowling Green & Owensboro Railroad Co.

Waycross & Dublin.—N. E. HARRIS and others of Macon, Ga., are to apply for a charter for a railroad from Waycross to Dublin. The project is said to be in the interest of the Plant system.

Wheeling, Wellsburg & State Line.—The surveys for this line in the West Virginia Panhandle and Western Pennsylvania have begun at Cannonsburgh, Pa. The first survey is to be made *via* West Middletown, Atchison and Bethany to Wellsburg, W. Va.

Columbia Short Line.—This company has been incorporated in Tennessee by N. N. COX, E. C. MCDOWELL, JOHN H. MOORE and others to build a road from Woodbury, Cannon county *via* Columbia to a junction with the Tennessee Midland.

THE NORTHWEST.

Existing Roads.

Chicago & Northwestern.—Mr. C. PALMER sends us an interesting account of the work in progress by this company on two large docks, for ore and timber at Escanaba, Mich. The lumber dock consists merely of two lines of piles 60 ft. apart, tied together with rods and lined with double sheet plank, forming a box which is filled with earth. The lumber dock is 2000 ft. long, and 60 ft. wide. The ore dock, which contains 250 pockets, is 1,500 ft. long, 36 ft. wide and 46 ft. high, with a double track trestle approach 1,000 ft. in length. The total amount of timber in both docks is 6,000,000 ft. B. M., besides 4,262 piles. Three steam pile drivers were used and two of these were supplemented by pumps and water jets, the bottom being pure sand. One machine drove 86 piles in one day. The fender piles were put in without a hammer, the water jet alone sinking them 23 to 24 ft. into the sand. The water jet was also used in sinking the sheet piling and 336 lin. ft. were put in in one day in this way. The pump used was a Worthington, with steam cylinders 16 ins. diameter, and water cylinders 10 ins. diameter.

This is the fourth ore dock built by the company at Escanaba. The general plan is like Nos. 2 and 3 which were designed by E. H. JOHNSON, now Consulting Engineer of the company. This dock, however, is 7 ft. higher and the operating parts have been modified from designs by H. G. BURT, Chief Engineer, under whose direction the work is being done, with S. H. SELDEN, Engineer in Charge. The dock is not quite completed, but the frame is up and the iron work is being put on and it will be ready for use by the opening of navigation.

Chicago, Milwaukee & St. Paul.—The annual report of this company shows that at the close of 1887 the total mileage of main track owned amounted to 5,670 miles. Of this 316 miles were in Illinois, 1,305 in Wisconsin, 1,573 miles in Iowa, 1,120 miles in Minnesota, 141 miles in Missouri, and 1,215 miles in Dakota.

The following statement shows the gross earnings and expenses for the year as compared with the year previous:

Earnings.	1886.	1887.	Increase.
From freight,	$17,358,294	$17,742,141	$383,847
From passengers,	5,661,689	5,849,260	187,571
From mails, ex., etc.,	1,698,418	1,774,721	76,302
Gross earnings.	$24,718,403	$25,366,123	$647,720
Total expenses,	14,560,.64	15,326,693	766,429
Net earnings.	$10,158,139	$10,039,430	.....

Thus it is seen that the net earnings decreased $118,708. The total net increase in funded debt for the year was $7,578,000, or about $20,500 per mile for the 370 miles constructed during the year.

The reduction in freight rates is noted as follows:

"During five years, from 1882 to 1887, the rate per ton per mile has been reduced from 1.48 cents to 1.09 cents, or 26.35 per cent.; and during the preceding five years, 1877 to 1882, from 2.08 cents to 1.48 cents, or 28.8 per cent. This makes a total reduction of 47.6 per cent. during ten years in the average rate charged for freight transported over your lines."

The report lays the blame for the decrease in net earnings and the present rate wars and disturbances upon that overburdened scape goat the inter-State commerce law. The two sections to which objection is made are the long and short haul clause and the clause prohibiting pooling of traffic and it is hoped, "that Congress in its wisdom will repeal the two objectionable sections, or so amend the law as to permit railway companies to charge rates for transportation that are in themselves reasonable and just, limited of course by the common law rule that all shippers and localities that are alike situated shall be treated alike; and also provide that the Federal judiciary shall on application after a hearing, determine when rates are unreasonable or extortionate, and when unjust discriminations are made against localities or individual shippers. Such legislation will not only fully protect the public who must use the roads, but will give to the owners of our railways the same protection, no more and no less than is now given under existing laws to investments in other corporate properties."

St. Paul & Duluth.—Work is to be resumed as soon as the weather permits on the work of reducing grades, ballasting, etc., between White Bear and Northern Pacific Junction. The line is to be double tracked between St. Paul and White Bear, 12 miles, and from Duluth to Duluth Short Line Junction, about 8 miles.

Duluth, South Shore & Atlantic.—A preliminary survey has been made from Newtonville to Lake Linden in the north Michigan peninsula. It is believed that the line will be built this season.

Chicago, St. Paul & Kansas City.—An extension from Belmond, Ia., to Algona, about 32 miles, is under consideration. It is reported that the latter city has offered a heavy subsidy in aid of the extension.

Illinois Central.—The Freeport, Dodgeville & Northern line is now completed to Dodgeville, Wis. This is the line which it has been rumored, the company intended to push on to St. Paul. In view of the present state of profits on traffic between St. Paul and Chicago, it is hardly likely that the Illinois Central will think it well to build toward the Twin Cities very rapidly.

Sault Ste. Marie & Southwestern.—This Wisconsin company, whose projected extensions were noted on our Map of the Northwestern States in ENGINEERING NEWS of Jan. 28, is endeavoring to obtain local subsidies for the new line.

Manitoba.—There is rejoicing in this Canadian Province over the final result of the long struggle with the Canadian Pacific. The terms of settlement are practically the same as announced in last week's issue. The Canadian Pacific Company will sell 7,000,000 acres to the Dominion Government at $1.50 per acre and re'inquish its granted right to a monopoly of the traffic of the northwest. It is likely that the Emerson branch of the Canadian Pacific will be purchased and the Red River Valley road completed. The news has given a start to the various Manitoba projects and will doubtless hasten the construction of lines to the boundary on the American side. The St. Paul, Minneapolis & Manitoba and the Northern Pacific have already built there, and it is not unlikely that several other of the Northwestern systems will claim a share of the traffic of the Manitoba wheat fields.

New Projects and Surveys.

Ontario, Manitoba & Western.—We are in receipt of a prospectus of this enterprise which is now endeavoring to obtain a charter at Ottawa. The proposed line is to run from Port Arthur to Winnipeg with a branch through southern Manitoba. The principal object of this line is as a competitor to the Canadian Pacific in transporting grain from Manitoba to Lake Superior. From Port Arthur it is estimated that when the canals on the Great Lakes and St. Lawrence are deepened to 14 ft. grain can be carried to Montreal for four cents per bushel. The Manitoba wheat crop for 1887, is given at 30,000,000 bushels, and the company proposes to carry wheat from Winnipeg to Port Arthur for 10 cents. Besides this traffic the line would develop large iron ore deposits, and the heavily wooded country about the Rainy river would furnish a great timber supply, for shipment to the settlers on the treeless prairies farther west. The total annual revenue from the lumber traffic is estimated at $1,748,250. The estimated cost of the road is $25,000 per mile, of which about $15,000 is for grading. The total distance from Port Arthur to Winnipeg and North Antler is about 580 miles, making the total cost about $15,000,000. It is proposed to bond the road for $20 000 per mile. The gross earnings for the first year are estimated at $2,171,000. The surveys which have been made have shown a practicable route with maximum grades of ½ of 1 per cent. and curves of three degrees. One point which is especially urged is, that the line will tend to prevent the diversion of the traffic of Manitoba, and the Northwestern provinces to the American railway systems, and will help to draw it toward Ontario and the eastern Provinces. Hon. JAS. CONMEE, M. P. P. of Toronto, is at the head of the enterprise.

Springfield & Southern.—President, RUFUS RAMSAY and Vice-President, C. D. HOILES are trying to raise funds in New York City, for the building of this Illinois road. It is reported that the location of the line will be changed, and a route will be surveyed *via* Breeze and Germantown.

Calgary.—A press dispatch from Calgary, Alberta, N. W. T. Canada, states that "Sir A. P. GALT DAVIS and others, are applying for a charter to build a railway from Calgary to a point in Montana.

Duluth, Red Wing & Southern.—A construction company has been organized at Red Wing, Minn., to build the Duluth, Red Wing and Southern Railroad. Ex-Governor HUBBARD is President.

St. Ignace, Sault Ste. Marie & Northern.—Organized to build an air line from St. Ignace to Sault Ste. Marie, about 25 miles. WM. CHANDLER, J. P. GOFF, C. S. OSBORN and others of Sault Ste. Marie are among the directors.

THE SOUTHWEST.

Existing Roads.

New York, Texas & Mexican.—It is reported that all arrangements have been made for laying a third rail from Collins, Tex., to Laredo, for the use of trains of the San Antonio & Aransas Pass system.

San Antonio & Aransas Pass.—This company has issued bonds at the rate of $8,000 per mile of completed road which will be used to refund the outstanding mortgages issued for construction and equipment. The report of the engineers who have been examining the site for the proposed bridge over the Colorado river at Austin, Tex., places the cost at $64 000. President LOTT has offered to build the road from Yoakum *via* Gonzales, New Braunfels, Luling and Lockhart to Austin, provided that a subsidy of $1,000 per mile, $75,000 toward the Austin bridge, and the right of way and depot sites, are all donated.

St. Louis, Arkansas & Texas.—The extension to Ft. Worth was finished April 1. The Shreveport & Arkansas has just reached Shreveport, La.

Central Missouri.—The name of this company has been changed to the Cleveland, St. Louis & Kansas City. The papers for the reincorporation were filed by Col. J. T. K. HAYWARD.

Southern Pacific.—A meeting was held at Victoria, Tex., on March 31, to raise aid for the extension from Victoria to Beeville.

Gulf, Colorado & Santa Fé.—A contract has been signed by this company and the citizens of San Angelo, Tex., by which the company agrees to extend the railroad from Ballinger to San Angelo if the citizens grade the road, and give right of way and depot grounds.

New Projects and Surveys.

Wichita, Meade Center & Western.—Incorporated in Kansas to build a railroad from a point in Sedgewick Co. to a point in Hamilton Co. General offices at Meade Center, Kan.

Fort Smith, Paris & Dardanelle.—This Arkansas project is still being agitated. President THOS. BOLES has asked a subscription of $40,000 from Fort Smith. The line is projected to run from Fort Smith to Dardanelle, about 75 miles.

Kansas City, Rich Hill & Southern.—This company is reported to have been reorganized so that work will be resumed early in the season. Mr. J. W. HEYLMUN of Rich Hill, Mo., is Chief Engineer.

Leavenworth & Denver Short Line.—The projectors of this Kansas enterprise are trying to enlist aid in Denver. H. M. ALLER, of Leavenworth, is President of the company.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Mexican National.—Advices from Col. D. C. DODGE, Vice-President and General Manager of this company, state that track is now down 45 miles from Saltillo and the grading is 75 miles ahead of the track. The rails will probably be laid from now on at a rate of 2 miles per day. Several large cargoes of bridge iron and rails are on their way from England and are to be forwarded at once.

Southern Pacific.—As we predicted last week, the published rumor that the company was to build a line from Montague, Cal., to Kelton, Utah, proves to be, in Vice-President CROCKER'S words "an invention having no foundation whatever in fact." On the Santa Rosa & Carquinez line the trackayers are between Sonoma and Glen Ellen, having 14 miles of track down. The line will probably be finished by June 1. The Eastern Oregon project noted on our map last week is again being put forward. The directors are soon to discuss the various lines on which work is proposed and will decide upon their plans for the season's work.

Montana Central.—The Wickes tunnel has advanced 2,200 ft. at the north heading and 1,325 ft. at the south heading. About 2,600 ft. are yet to be bored.

Oregon Ry. & Navigation Co.—This company is reported to be asking bids for the construction of the line to Heppner, noted as surveyed on our map in last week's issue. The line from Wallula to Estes is also to be pushed and it is likely that both will be completed this year. Their combined length will be about 83 miles.

Sinaloa & Durango.—It is reported that this Mexican company has been granted a subsidy of $12,875 per mile for a road from the present southern terminus at Guaymas south to Mazatlan.

Atchison, Topeka & Santa Fé.—The following corrected list of construction on lines of this system in California, for which we are indebted to the courtesy of Mr. FRED. T. PERRIS, Chief Engineer, reached us too late for insertion in our last week's list: Track laid in 1887, San Bernardino to Los Angeles, 60.4 miles; Arlington to Santa Ana, 33.5 miles; Santa Ana to near San Juan, 24.4 miles; S. B. & S. D. Junction, 2 miles north of Oceanside towards San Juan, 1 mile; Escondido Junction to Escondido, 21.2 miles; Los Angeles to Port Ballona, 18 miles; San Bernardino west towards Mentone, 6.9 miles. Lines under construction, Los Angeles to Orange, 31.6 miles; near San Juan to S. B. & S. D. Junction, 2 miles north of Oceanside, 24 miles; 6.9 miles west of San Bernardino to Mentone, 5.3 miles; Perris to San Jacinto, 19.4 miles; Inglewood to Redondo Beach, 10 miles. Now under survey, Escondido to San Diego, via El Cajon, 50.8 miles. Total track laid, 165.4 miles. Total under construction, 90.3 miles.

Santa Ana, Fairview & Pacific.—An Associated Press report from Santa Ana, Cal., states that contractor THOS. KILPATRICK has begun grading on this road.

Chicago, Rock Island & Pacific.—The directors of this company have approved the location of the 300 mile extension to Colorado Springs, Col.

Northern Pacific.—Surveys are reported in progress on the Central Washington line, recently incorporated by this company, to run from Cheney, W. T., to the Big Bend and Salmon river districts.

New Projects and Surveys.

Walla Walla & Wallula.—Contractor G. W. HUNT has proposed to the Walla Walla Board of Trade to build a road from that point to Wallula to connect with the Cascade branch of the Northern Pacific, for a subsidy of $100,000. The road would be a direct competitor of the present Oregon Ry. & Navigation Co.'s line.

Ilwaco Steam Navigation Co.—A short railroad is to be built by this Washington Territory company. H. S. GILE of Portland, Ore., J. H. D. GRAY of Astoria, L. A. LOOMIS of Ilwaco, and others are interested.

Coast Range Development Co.—Incorporated at Oakland, Cal., by M. B. CURTIS, E. H. CAMPBELL, and others. The company will lease and operate the California & Nevada Narrow Gauge road; but by the terms of its charter it can also engage in all sorts of engineering work.

Contracting.

Tunnel and Paving.—The proposals opened at Newport, R. I., March 23, by H. A. BENTLEY, City Engineer, for sewer tunnel excavation, ranged from $8.90 to $19.50 per lin. ft.; 13 bids were received; the contract was not awarded. There was only one bid for asphalt paving, $2.75 per yd.; the contract was not awarded.

The Chicago Artesian & Rock Well Co., of Chicago, Ill., has been incorporated by MARTIN R. JOHNSON, F. W. CORAKE and G. A. CHASE. Capital stock, $35,000.

Trestle Work and Piling.—At Portland, Ore., the contract for piling and trestle work to complete the Portland & Willamette Valley Ry. to the public levee, about half a mile, has been awarded to Hoffman & Bates, who also have the contract for the wharf, etc.

The Costa Rica Exploration Co. has been incorporated in San Francisco, Cal., by ERNST A. DENICKE, C. K. BONESTELL and JACOB FROWENFELDT. Capital stock, $15,000.

The American Patent Drill & Reamer Co. has been incorporated by Dr. JULIUS H. RAU, WM. C. CHAPIN and others, of San Francisco, Cal., to deal in tools for artesian well work. Capital stock, $100,000.

Boiler.—The following proposals for a steam boiler for the improvement work on the Cape Fear river, were opened March 15, by Capt. W. H. BIXBY, U. S. Engineer Office, Wilmington, N. C.: Theodore Smith, Jersey City, N. J., $3,045; E. J. Codd, Baltimore, Md., $3,980; J. P. Morris & Co., Philadelphia, Pa., $4,319; Charles Ward, Charleston, W. Va., $3,500 for 1,320 sq. ft. of heating surface or $4,000 for 1,630 sq. ft.; Southwark Foundry & Machine Co., Philadelphia, Pa., $5,216 (not considered). The contract was awarded to Theodore Smith.

Pumping Engines and Pipe.—The following proposals have been received by the Water-Works Commission, Welland, Ont., JOHN F. GROSS, Secretary: Volker & Felthousen Mfg Co., Buffalo, N. Y., **A**, duplex power pump, 1,500,000 galls. capacity, $1,300, and 750,000 galls. capacity, $910; total $2,210; **B**, $1,560 and $1,092, total $2,652. Ontario Engine & Machine Works (C. Smith & Co.), Toronto, $900 for 1,500,000 galls. pump and $725 for 750,000 galls. Northey & Co., Toronto, $4,600 for 2 pumps with pipe connections inside pump house. Wm. Kennedy & Sons, Owen Sound, Ont., $2,675 for 750,000 and 1,500,000 galls. pumps. Holly Mfg. Co., Lockport, N. Y., pumps of 750,000 and 1,500,000 galls. delivered and erected, $3,850 if the commissioners pay the duty, or $3,500 and 30% duty. J. D. Ronald, Brussels, Ont., $5,000. The contract was awarded to Wm. Kennedy & Sons.—The following were the proposals for pipe: Le Vallie & Co., Montreal, $38 per ton; T. Turnbull & Co., Montreal, $40.80, $39.50, $38.99 and $38.98 for 3, 5, 6 and 8-in. pipe; Wm. McNally & Co., Montreal, $41.20 per ton; St. Lawrence Foundry, Toronto, $40, $42, $41 and $40 for 3, 5, 6 and 8-in. pipe, and $47 for 3-in. pipe 12 ft. long. The contract was awarded to Le Vallie & Co.

Water-Works.—The following proposals have been received by the Water Board, Lapeer, Mich., J. B. MOORE, President: M. Walker, Port Huron, complete works except wells and engine house, $14,856 with cast-iron pipe or $34,000 with kalomein pipe. Dennison & Cowell, Muscatine, Ia., complete, except as above and excepting pumping machinery, $31,950. Michigan Pipe Co., Bay City, Mich., similar conditions as the previous bid, $25 644.50, with wood pipe; for machinery, $7 200, $4,200, $5,300. W. S. Parker & Co., New York, complete works, $39,446. Lansing Iron & Engine Works, Lansing, Mich., $38,000 for complete works except wells and house. Geo. C. Morgan, Chicago, similar conditions, $36,266 with wood pipe, $39,679 with cast-iron pipe, $42,519 with kalamein pipe. Rhead Bros., Lapeer, similar conditions, $35,739. Keating Bros., Detroit, $28,000 for works complete except wells and pipe laying. Detroit Pipe & Foundry Co., Detroit, cast-iron pipe and specials, $28 and $46 per ton.

Bridge.—The following proposals for a bridge over the Kalamazoo river, at East Ave., Kalamazoo, Mich., have been received by CHAUNCEY STRONG, City Clerk: *Superstructure*, Wrought Iron Bridge Co., Muncie, Ind., $14,100; Pittsburg Bridge Co., Pittsburg, Pa., $14,500; Smith Bridge Co., Toledo, O., $14,590; Massillon Bridge Co., Massillon, O., $14,600; King Iron Bridge & Mfg. Co., Cleveland, O., $14,840; P. E. Lane, Chicago, $14,800; Penn Bridge Co., Beaver Falls, Pa., $14,875; Mt. Vernon Bridge Co., Mt. Vernon, O., $14,925, Columbus Bridge Co., Columbus, O., $14,998; Milwaukee Bridge & Iron Works, Milwaukee, Wis., $15,030; Indiana Bridge Co., Muncie, Ind., $15,300; Variety Iron Works Co., Cleveland, O., $15,600 and $15,825.—*Substructure*; H. J. McHugh, $3,566; G. C. Winslow, $4,949, $5,519 and $5,994; B. Roe, $5,042. The superstructure will consist of two spans, 125 ft. each, roadway 24 ft. in the clear; two sidewalks 5½ ft. each in the clear. Load 100 lbs. per sq. ft. of floor; skew, approximately 45°. GEO. S. PIERSON is City Engineer.

Engine and Boiler House.—The following proposals for building an engine and boiler house at Bedloe's Island, New York harbor, were opened March 31, by Major D. P. HEAP, U. S. A., Tompkinsville, N. Y.: Charles Diem, Albion, N. Y., $8,894.97; Colin McLean, New York, $9,200; James H. Coster, Baltimore, Md., $9,500; Philip J. McGuire & Co., New York, $9,700; Robert Moore, West New Brighton, N. Y., $9,975; Philip Wolff & Son, Stapleton, N. Y., $10,434; Frank Rinschler, Stapleton, N. Y., $10,499; James Thompson, Rosebank, N. Y., $11,750; Thomas Farrelly, New Brighton, N. Y., $12,200.75; F. H. Smith, New York, $12,490; Linus Seely, Deering, Me., $13,675; E. D. Garnsey & Bro., New York, $13,685.

City Lighting.—The following proposals for lighting the streets with gas and electric light were opened March 27 by the Commissioner of Public Works, New York City: *Gas;* Equitable Gas Co., $12 per light per annum; Consolidated Gas Co., $17.50; Mutual Gas Co., $17.50; New York & New Jersey, (23d and 24th Wards), $21.50, $23.50 and $25; Central Gas Co., (23d Ward), $28; Northern Gas Co., (24th Ward), $29; Yonkers Gas Co., $29.—*Electric*, (lights of 1,000-candle power): Brush Electric Light Co., 381 lamps at 44 cts. per night and 52 at 39 cts. United States Electric Light Co., 19 lamps at 42 cts., 38 at 44 cts., 13 at 47 cts., 339 at 49 cts. Harlem Electric Light Co., 207 lamps at 39 cts., 29 at 40 cts., 38 at 41 cts., 124 at 42 cts., 12 at 45 cts., 19 at 50 cts., 50 at 60 cts. Mount Morris Electric Light Co., 87 lamps at 32 cts., 143 at 39 cts., 80 at 40 cts. East River Electric Light Co., 162 lamps at 32 cts., 252 at 59 cts., 212 at 41½ cts. Ball Electric Light Co., 72 lamps at 50 cts. on Broadway and 6th Ave. from 23d to 59th Sts. North New York Electric Light Co., 370 lamps at 39 cts.; any required number of incandescent lamps at 7 cts. per night.

Paving Blocks and Stone.—The following proposals for 650 tons of rubble stone, 8,000 paving blocks and 210 cu. yds. of dimension stone, for Stony brook improvement, were opened March 24 by SETH PERKINS, Superintendent of Sewers, Boston, Mass.: S. & R. J. Lombard, Charleston, $2.87 per ton, 21 cts. each, $12 per cu. yd., $6,065.50; James J. Vernon, Lanesville, Mass., $3, 25 cts., $15.25, $6,152.50; Shields & Carroll, Boston, $2.24, 19 cts., $12.37, $6,223.70; Rockport Granite Co., Rockport, Mass., $2.80, 21 cts., $18.60, $7,406; Thomas A. Rowe, Brookline, $4, 25 cts., $16, $7,960; Edward C. Munson, Allston, $4.50, 27 cts., 16.50., $8,550. The contract was awarded to S. & R. J. Lombard.

Water-Works Supplies.—The Committee on Water, Richmond, Va., has awarded the following contracts: Smith & Courtney, Ludlow hydrants, 4, 6 and 8-in, Ludlow valves; brass stop cocks, tallow; Tredegar Co., special castings, 2½ cts. per lb.; Southern Stove Works, stop cock boxes; G. & A. Borgamin, pig lead, 5.46 cts. per lb.; Southern Railway Supply Co., tapping and corporation cocks; W. T. Ford, excavating pipe trenches, pave l streets 39¾ cts. per cu yd., gravel 34¾, clay 29¾; W. M. Brown, new stone paving 75 cts. per sq. yd., old paving 30 cts., cinders 75 cts. per cu. yd.; L. Wagner, castor, sperm and kerosene oil. All bids for pipe were rejected, and sealed proposals for 4, 6 and 8-in. pipe will be received until April 9.

Denver Capitol.—The Board of State Capitol Managers, Denver, Col., have received the following proposals for the completion of the foundation walls of the new Colorado State Capitol: E. S. Barker, Denver, $59,403.75 + $2 per iron beam placed; Geddes & Seerie, Denver, $59,750; McDermott & Bain, Fort Collins, $61,750; Hayes & McGilvray, Denver, $67,000; Harvey Bros., Denver, $89,000. The contract was awarded to Geddes & Seerie as the lowest bidders. The prices were as follows: backfilling, 22¾ cts. per cu. yd.; rubble masonry, 32 cts. per cu. ft.; dimension footing, 70 cts. per cu. ft.; dimension pier binders, 75 cts. per sq. ft.; 4-in. flagging, 35 cts. per sq. ft.; rough footings masonry, 40 cts. per cu. ft.; setting 460 iron floor beams for basement floor, $399.50. D. W. CAMPBELL is the engineer.

The Italian Society of Emigation was organized in this city about 6 months ago by some leading men of the Italian community, for the purpose of rendering assistance to emigrants and protecting them from the men who, by the padrone system, impose upon their ignorant countrymen and exact payment of a large proportion of the wages they receive. The greater number of these emigrants of the laboring classes who come to this country can only speak their own language, and are, therefore, ready to trust the Italian speaking bosses, and as they are entirely ignorant of the customs and laws of this country they are easily managed and have no means of seeking protection or making conditions more satisfactory to themselves. The society does not interest itself in inducing emigration but confines itself to protecting Italians of the working class who arrive here, and to securing work for both common laborers and skilled workmen under h nest arrangements. This class of emigrants is very large and is one of the main sources from which labor is drawn, especially for railroad work. The society gives references to all the Italian consulates of this country, and contractors and other employers of labor would do well to apply to it when in need of men. R. MARZO is General Manager, and the office is at 24 State St., New York City.

River and Harbor Bill.—The total of the bill for this year, as submitted to Congress, is $19,433,783.13.

Electric Railway.—Henry Ritchie has the contract for the last section let, about 1¼ miles, of the Citizens' Electric Ry., at Little Rock, Ark. Further contracts will be let this season.

Sewers.—The City Council of Trenton, N. J., at their meeting on the 30th ult., decided to re-advertise for proposals on account of the bids received being irregular, and not according to the printed instructions.

Reservoirs.—The following are the totals of proposals for reservoirs, gate-houses, etc., received by the Special Water Commission, Albany, N. Y.: Cranford & Valentine, Brooklyn, N. Y., $271,594; Jacob Holler, Albany, $375,127.59; Sullivan & Ehlers, Albany, $421,015.50; Houlihan & Fiegler, Cohoes, $485,628.83; John H. O. Rourke, Brooklyn, $490,357.92. The contract was awarded to Cranford & Valentine.

Sewer Contracts.—*Jersey City, N. J.*—The following proposals have been received by the Board of Public Works for a 24-in. brick sewer in Laidlaw Ave.: Michael Curley, sewer $1 per ft., rock excavation, 45 cts. per cu. yd., receiving basins $1 each, concrete 1 ct. per cu. yd.; P. O'Neill, $3.50, $2.35, $80, $70; M. B. Allen, $3.20, $2.50, $85, 45 cts.; T. Cogan, $2.90, $2.50, $80, $1.

Trenton, N. J.—The following proposals have been received by the Sanitary Committee: P. J. Condon, $17,949.25; B. M. & J. F. Shanley, $42,076.51; Daniel Lodor, $45,936.39; Crawford & Roney, $46,319.25; Ard Bros., $56,-296.70; W. H. H. Achuff, $61,026.40; Thos. Craig, $61,827.08; James Deehan, $86,024; Conway & McManus, $34,042.20 for a portion only; Waite & Van Harlingen, $14,182.76 for a portion only. All the bids were rejected and the work will be readvertised.

Allegheny, Pa.—JAMES BROWN, City Comptroller, has awarded contracts to H. Lafferty for the California Ave. sewer, at $2,280.70, and for the Niggel St. sewer for $1,056.75.

St. Paul, Minn.—The Board of Public Works has awarded sewer contracts as follows: G. Moline, $1,124.-82; McArthur Bros., $54,000.

Beatrice, Neb.—The contract for the sewerage system has been awarded to M. Duffield.

Bridge Contracts.—*Utica, N. Y.*—The Hilton Bridge Co., of Albany, has the contract for the iron work of the lift bridge over the Erie canal at John St., and M. Drum, of Greenbush, is building the masonry. The plans were prepared by JAMES SHANAHAN, Superintendent of Public Works, Albany. The bridge will be 96 ft. long, with a roadway 24 ft. wide and two sidewalks 5 ft. 6 ins. wide.

Baltimore Co., Md.—The following proposals for a bridge over Gunpowder falls have been received by W. H. SHIPLEY, Bridge Superintendent, Baltimore: Wrought Iron Bridge Co., Canton, O., $4,472; Milwaukee Bridge & Iron Works, Milwaukee, Wis., $4,720; Pittsburg Bridge Co., Pittsburg, Pa., $4,745; Penn Bridge Co., Beaver Falls, Pa., $28.25 per lin. ft., $4,943.75; King Iron Bridge & Mfg. Co., Cleveland O., $5,262; Lane Bridge & Iron Works, Chicago, Ill., $5,280; Dean & Westbrook, New York, $5,300; H. A. Ramsay & Son, Baltimore, $5,-795; Mt. Vernon Bridge Co., Mt. Vernon, O., $6,550.

Milledgeville, Ga.—The contract for replacing the span of the Oconee river bridge that was washed away recently has been let to Samuel Ennis at $1,800.

Shorts Ford, Mo.—The contract for a bridge across the Meramec river at Short's Ford, near Moselle, has been awarded to the King Iron Bridge & Mfg. Co., of Cleveland, O., at $3,759.

St. Paul, Minn.—The Committee on Roads and Bridges has awarded the contract for the Lyndale Ave. bridge to the Wrought Iron Bridge Co., of Canton, O., at $19,515. The contract for the substructure was awarded to the Minnesota Stone Co., for $6,199.75.

Denver, Col.—The following proposals for a bridge over the Platte river on the road to the military fort have been received by the County Commissioners: R. Jackson, $885; Jos. Williams, $940; L. E. Forbes, $1,470; J. J. Ash, $1,619.

La Grange, Tex.—Contracts have been awarded to the Missouri Valley Bridge Co., of Leavenworth, Kan., for 4 iron bridges, and to the King Iron Bridge & Mfg. Co., of Cleveland, O., for 2 iron bridges.

Ballinger, Tex.—The contract for the Colorado river bridge has been awarded to S. Leversedge, of Dallas, for $14,780, the lowest bid. There will be an iron span of 180 ft. and 250 ft. of trestle.

Waco, Tex.—The contract for an iron truss bridge over the Brazos river has been awarded by the County Commissioners to Lee, Slaughter & Co., $49,500.

Sewers at Amsterdam, N. Y.—The following are the totals of bids received for material and labor for districts No. 1 and No. 7: *Material*; Carpenter & Woodruff, Troy, $6,096.90; John McEneroe, Schenectady, $6,-138.46; Sherman & McDonough, West Troy, $6,236.54; James J. Dwyer, Utica, $6,515.59; Wm. Fuller & Son, Albany, $5,960.84 (incomplete).—*Labor*, (Proposal No. 1); District No. 1; Matthias & Phillips, Amsterdam, $13,357.57; John T. Charles, Amsterdam, $14,996.50; Sherman & McDonough, West Troy, $16,182; Patrick Shannon, Amsterdam, $17,396.95; Van Vranken & Clements, Schenectady, $17,849.50; H. L. Brown, Mohawk, $18,812.75; Stanton & Neary, Cohoes, $19,051.10. District No. 7; Matthias & Phillips, $8,640; John T. Charles, $9,379.09; Sherman & McDonough, $10,237.50; Van Vranken & Clements, $10,-913; H. L. Brown, $11,094.25; P. Shannon, $11,274.75; Stanton & Neary, $11,678.75.—(Proposal No. 2): District No. 1 and No. 7 respectively: Patrick Shannon, $11,521.95, $5,469; Van Vranken & Clements, $11,906.75, $6,340.50; Chase, Skinner & Co., Little Falls, $13,345, $6,828.50; Sherman & McDonough, $13,926.25, $7,259; H. L. Brown, $19,713, $9,435.

The contracts were awarded as follows: *Material*; Carpenter & Woodruff, Troy; 8, 10, 12, 15 and 18 in. sewer pipe, 22½, 32½, 42½, 75 cts. and $1.02 per ft.; same sizes of Y branches, $1.01, $1.46, $1.96, $3.38 and $4.59; 3, 4 and 6-in. drain tile, $15, $33, $70; bricks, $4 per M.; Portland and Rosendale cement, $2.50 and 75 cts. per bbl.; boards, $11 per 1,000 ft. B. M.; iron pipe, $22 per ton; iron bends and covers, 3 and 1½ cts. per lb.; total, $6,096.90.—*Labor*: Patrick Shannon, Amsterdam; (same prices for Districts No. 1 and No. 7); excavation, to 2 ft. deep, 8 cts. per lin. ft.; 2 to 3 ft., 12 cts.; 3 to 4 ft., 16 cts.; 4 to 5 ft., 20 cts.; 5 to 6 ft., 24 cts.; 6 to 7 ft., 28 cts.; 7 to 8 ft., 32 cts.; 8 to 9 ft., 36 cts.; 9 to 10 ft., 40 cts.; rock, $2.16 per cu. yd.; laying 8, 10, 12 and 18 in. pipe, 3 cts. per ft.; drain tile, 1 ct. per ft.; manholes and flush tanks, $15 each; outlet chamber, $40; inspection pipes, $2.20; 6 and 14-in. iron pipe, 8 and 15 cts. per ft.; totals, $11,521.95 and $5,469. WM. B. LANDRETH, of Landreth & FitzGerald, Schenectady, N. Y., is the Engineer, and F. E. CRANE is Assistant Engineer.

Pumping Engines.—The following proposals for 5 pumping engines, with boilers, etc., for the city water supply, were opened March 31, by GEO. B. SWIFT, Commissioner of Public Works, Chicago, Ill.: E. P. Allis, Milwaukee, Wis.; 5 engines; cylinders, 27, 48 and 70 ins.; stroke, 60 ins.; 3 pumps, 23¾ ins. by 60 ins.; 15 boilers, 62 ins. by 20 ft., with 49 4-in. tubes; duty 125,000,000; price, Plan A, $369,785; Plan B, $354,785. Henry R. Worthington, New York; 5 engines; cylinders, 26½, 42, 51 and 51 ins.; stroke, 60 ins.; 4 pumps, 34¼ ins. by 60 ins.; 23 boilers, 56 ins. by 18 ft., with 42 4-in. tubes; duty 137,000,000; price $450,000; also an informal bid for 5 engines with 2 cylinders of 28¾ ins. and 2 of 57½ ins., all other particulars similar to the above, duty 110,000,000, $380,000. Quintard Iron Works, New York; 5 engines; cylinders, 20, 32½ and 56 ins.; stroke, 8 ft.; 3 pumps, 26½ ins. by 8 ft.; 22 boilers, 57 ins. by 16 ft., with 38 4-in. tubes; duty, 110,000,000 at 150 lbs. pressure and 100,000,000 at 120 lbs; price, $625,000.

Pipe.—The Board of Public Works, Providence, R. I., has awarded a contract for cast-iron water-pipe to the Gloucester Iron Works, Gloucester, N. J., at the following prices: 12-in. pipe, $29.28 per ton; 6-in. pipe $29.69 per ton.

The Reliance Gauge Co., Cleveland, O., has an order from the Windisch-Muhlhauser Brewing Co., of Cincinnati, for safety water columns.

Dredging.—The following was the only proposal for improving Sheepshead Bay, N. Y., received March 29 by Lt. Col. G. L. GILLESPIE, U. S. Engineer Office, New York City: Michael H. Flannery, New York, 50 cts. per cu. yd., $9,000.

The Metallic Street Railway Supply Co., of Albany, N. Y., issues a pamphlet descriptive of its metal track (Gibbon's patent) for street railways.

Railway Work.—The following particulars relate to the depression of the New York Central tracks at Harlem; WALTER KATTE, Chief Engineer:

Material.			Price.	Amount
51,040	cu. yds.	solid rock	$ 1.50	$76,560
58,090	"	loose rock	.75	43,567
457,080	"	earth	.50	228,540
3,015	"	1st class masonry	27.00	81,405
87,100	"	2d "	9.00	783,900
2,000	"	3d "	7.00	14,000
2,590	"	4th "	4.00	10,360
5,000	"	concrete	6.00	30,000
215,000	lin. ft.	piling	.30	64,500
248,250	ft. B. M.	yellow pine timber	35.00	8,689
41,375	"	white pine timber	35.00	1,448
41,375	"	hemlock	20.00	828
60,000	lbs.	wrought-iron	.04	2,400
1,000,000	brick.		17.00	17,000
64,800	cu. yds.	ballast	1.75	113,400
Total				$1,476,597

Summary of Total Amount of Bids.

M. S. Coleman, $1,272,198; Sherman & McDonough, $1,277,018; Smith, Ripley & Co., $1,283,408; Clark & Westbrook, $1,303,224; John D. Andrews, $1,314,890; John Cox & Co., $1,384,728; John F. Dyer, $1,410,383; Arnold & Stephens, $1,412,440; Sweet & Shanahan, $1,485,009; Ward, Lary & Co., $1,505,240; Howard Soule, $1,53.,607; Joseph Richardson, $1,541,875; Thos. Rutter & Co., $1,550,732; A. Van Wagner & Co., $1,635,066; Smith & Plunkett, $1,750,-166; Myles Tierney, $1,754,836; A. M. Newman & Co., $1,875,340.

Dams.—The big dam at the Connecticut works of the Seth Thomas Clock Co., which broke a few weeks ago, is being rebuilt, and will be a solid masonry structure. The engineers are HULL & PALMER, of Bridgeport, Conn., who are also preparing plans and specifications for a dam at Easton, Conn.

Retaining Wall.—The following proposals for about 290 lin. ft. of vertical wall in cement, on the Glens Falls feeder, have been received by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y.: Swan & Reilly, Glens Falls, N. Y., $2,209; John F. Clark, Fort Edward, N. Y., $2,373.75.

Boilers.—The following proposals for boilers for the Navy Department have been received by JAMES FULTON, Paymaster General, U.S.N., Washington, D. C.: Babcock & Wilcox Co., New York, $23,896; Jas. P. Witherow, Pittsburg, Pa., $16,800 and $16,550 for 5 and 4 boilers; National Water Tube Boiler Co., Philadelphia, $20,000; Geo. M. Newhall & Bro., Philadelphia, $16,900; Abendroth & Root Mfg. Co., New York, $19,270.

Tunnel.—The following is the engineer's estimate for the Lake Tunnel at Cleveland, O., the contract prices of which were given last week:

Lake tunnel	$156,420
Excavation, 22,000 cu. yds	33,000
Two working shafts	8,000
Two connection shafts	10,000
One inlet shaft	12,580
Total	$220,000

Drilling and Blasting.—The following proposals for drilling and blasting at St. Mary's Falls canal were opened March 26 by Lt. Col. O. M. POE, U. S. Engineer Office, Detroit, Mich.: Hickler & Green, Sault Ste. Marie, Mich., $4.47 per hole, contractor furnishing the explosive; $3 per hole, the Government furnishing the explosive; Carkin, Stickney & Cram, East Saginaw, Mich., $5.20, $3.75; Ingles & Hillman, New York City, $25, $23.

Proposals Open.

Water-Works.—Capacity for population of 10,000. About 4,000 ft. of 8 or 10-in. and 2,000 ft. of 2 or 3-in. pipe and specials, 18 fire plugs. From low water level at pump house to highest point in the city, 4,000 ft.; elevation 115 ft.: 120 ft.; fire stream 100 ft. high by direct pressure at this point. S. Q. SEVIER, President, Camden Water-Works Co., Camden, Ark.

Sewers.—To cost about $30,000. JOHN J. GRANVILLE, City Engineer, East Saginaw, Mich.

Railways.—In Chili. F. A. BEELEN, Consul General of Chili, 15 Cortland St., New York City.

Water-Works.—A. VENABLE, South Boston, Va.

Stone.—Granite curbstones, 7,000 lin. ft.; 120,000 granite paving blocks. HENRY D. FOSS, Superintendent of Streets, Springfield, Mass. April 10.

Sewers, Bridge Work, Etc.—Branch sewers; bridge at 6th St.; removing temporary bridge and piers. LOUIS WAGNER, Director of the Department of Public Works, Philadelphia, Pa. April 10.

Sewers.—Brick 33-in., pipe 12-in. Materials furnished. THE BOARD OF PUBLIC WORKS, Providence, R. I. April 10.

Street Work.—THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. April 10.

Drawbridge Engine.—Engine and engine room for draw span of Central Viaduct. W. P. RICE, City Engineer, Cleveland, O. April 12.

Street Work and Sewers.—Paving with pine blocks treated with chloride of zinc; granite paving, etc.; brick and pine sewers. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. April 13.

Sewerage System.—J. L. LUDLOW, Engineer, Raleigh, N. C. Time extended to April 16.

Sewers.—THE COMMISSIONER of PUBLIC WORKS, 31 Chambers St., New York City. April 16.

Water-Works Supplies.—Pipe, castings, hydrants, brass work, pipe laying, lead pipe, etc. JAS. A. BOUSTEAD, Chairman, Water-Works Committee, Toronto, Ont. April 16.

Water-Works.—Complete system; specifications on file. JOHN BLACK, Water Commissioner, Dalton, Ga. April 16.

Water Bonds.—For $75,000. H. M. NEWTON, Secretary, Water Commissioners, East Saginaw, Mich. April 17.

Iron, Slate and Copper Work.—U. S. Building, Rochester, N. Y. WILL A. FREBET, Supervising Architect, Treasury Dept., Washington, D. C. April 17.

Bridge.—Plans and specifications on file. WM. FISHER, County Commissioner, Dover, Del. April 17.

Boilers.—Two tubular boilers. W. W. MEAD, Lieut. Commander, U. S. N., New Orleans, La. April 19.

Submerged Pipe Laying.—Furnishing 16-in. pipe, with castings, valves, etc., and laying it across Maumee river; about 2,445 ft., of which about 1,500 ft. will be under water. About 214 tons of 16-in. pipe, not less than 170 lbs. nor more than 175 lbs. per ft.; also 2 16-in. stop valves and 2 12 × 16-in. four way valves. THE TRUSTEES OF THE WATER-WORKS, Toledo, O. April 19

Water-Works.—At Goderich, Ont. Cast-iron pipe 560 tons of 4, 6, 8 and 10-in pipe; specials; 45 hydrants; 30 valves; excavating, laying and backfilling for 35,000 ft. of pipe; 2 pumping engines of 1,000,000 galls. daily capacity each, direct pressure system, 350 ft. head; 2 return tubular boilers. WILLIS CHIPMAN, Engineer, Brockville, Ont. WILLIAM CAMPBELL, Town Clerk, Goderich, Ont., Canada. April 24.

Water-Works.—Population, 6,000. About 8 miles of street mains and 85 hydrants. Terms for 20 years. WM. HENRY, Mayor, Jackson, Miss. April 25.

Water-Works.—N. O. BERRY, Goldsboro, N. C. April 25.

Wood-Paving and Street Railway Tracks.—Laying plank; pine block paving; laying double track railway on Central Viaduct. W. P. RICE, City Engineer, Cleveland, O. April 26.

Dike and Stone.—Dike in Delaware river near lower end of Reedy Id.; stone for dike in Delaware river near Mifflin bar, between Hog and Maiden Ids. Lt. Col. H. M. ROBERT, U. S. Engineer Office, Philadelphia, Pa. April 27.

Paving Bonds.—For $15,000. ROBERT W. DAVIS, Village Clerk, Gladstone, Delta Co., Mich. April 27.

Jail.—Proposals for building complete or separate bids for iron work and building. THE COUNTY COMMISSIONERS, Tampa, Fla. May 1.

Railway.—Grading the Hereford Ry. Plans and specifications at the office of the engineer, Cookshire, or at the office of the Upper Coos Ry. Co., West Stewartstown, N. H. D. WILLIAMS, Engineer, Hereford Ry., Cookshire, Que., Canada, May 1.

Railroad.—Grading the extension of the A. T. & S. Fé. R. R. from Ballinger, Tex., to San Angelo. W. S. VECK, Chairman of the Railroad Committee, San Angelo, Tex.

Track Material.—Material for 6 miles of track; 50 or 35 lb. iron or steel rails, splice plates, etc. G. G. CULPEPPER, Boston, Ga.

WATER.

Ohio Water-Works.—The Senate has passed a bill providing that Water-Works Trustees shall not hold any other office of trust or profit under the city, and that the books of the Department shall be left open for public inspection, and also requiring the consent of the Council to the appointment of under officials.

West Troy, N. Y.—The Governor has signed the bill authorizing the Sewer Commissioners to contract with the water company for a supply of water for flushing the sewers, at not more than 15 cts. per 1,000 galls. and at an annual expense of not more than $800. The contract is not to exceed 10 years.

Well Water.—At Cleveland, O., it has been ascertained that 6,300 wells are being used by families living on streets in which water pipes are laid, and the Board of Health thinks that the use of water from these wells is dangerous. The board has full power to order the filling up of any well believed to be dangerous to health, and can also compel families to use lake water; if the order is not complied with the board can have the work done and charged to the property owner. There are 534 streets in which no water pipe has been laid, and many residents desire lake water but cannot secure a sufficient number of signatures to a p tition to warrant the Water-Works Trustees in ordering the pipe laid.

New London, Conn.—The Supreme Court has rendered its decision in the sewer appeal cases; the decis on sustains the Board of Sewer Commissioners in every point, declares the notices legal and confirms the assessments made by the Board. The plan of the sewer, which was objected to as having only one outfall, is considered proper and reasonable, and the objections that the system does provide for cellar drainage and that the grade is only 1 in 1,000 are not valid from an engineering point of view. The private sewers which were claimed by the appellants to exempt them from liability to contribute to a public system of sewerage, are declared to be intolerable nuisances which ought to be abated, thus disposing of the claim that proprietors of land on the waters of the harbor had a natural right of sewerage to the sea. The Board of Sewer Commissioners is declared to have power to prohibit all private sewerage and to enforce a proper system of sewerage. W. H. RICHARDS is Engineer to the Board.

Norfolk, Va.—The Water Committee has made its report on the quality and quantity of the water supply. Propositions had been received from several filtering companies to filter the supply at costs of from $35,000 to $50,000; also a proposition from the Lake Drummond Water Co. to furnish water from Deep Creek for a very large proportion of the city water receipts. The driven well system had been investigated and H. E. Knox has made borings and located a suitable site for wells. An appropriation of $1,500 was made to continue the investigations and to send City Engineer BROOKE and Engineer WRIGHT, of the water department, to Hoboken, N. J., to investigate the air compressor in use in that city in connection with the gang wells.

Marinette, Wis.—The water-works are being put in by the American Water Works & Guarantee Co., of McKeespert, Pa. There are to be 12½ miles of pipe, 125 hydrants and 2 Worthington pumping engines with a daily capacity of 4,000,000 galls.; only one engine will be operated at a time. The pumping plant is located on the bank of the river, and the 20-in. intake pipe is laid across the river and into the bay a sufficient distance to obtain pure water, uncontaminated by sewage. The distribution mains are 6, 8, 10 and 12 ins. diameter. The hydrant rental is $46 each per annum, for the 125, and $30 each for additional hydrants. The city has the option of buying the works at the end of 10 years or continuing to the end of 20 years under the present contract.

Electric Light and Gas.—*Gardner, Mass.*—The Gardner Electric Co. has been organized with a capital of $15,000. It proposes to supply electricity for light, heat and power; the Thomson Houston system will be used. CHAS. S. RICHARDSON is Clerk.

Annapolis, Md.—The Annapolis Electric Light Co. will begin operations as soon as the right of way through the city is obtained.

Frederick, Md.—A satisfactory test of the new Thomson-Houston system was made recently.

Alexandria, Va.—The gas works are to be altered and improved. Bartlett & Hayward, of Baltimore, Md., will do the work.

Richmond, Va.—The Board of Aldermen has adopted a resolution providing that the Joint Committee on Finance and Light be authorized to receive bids for leasing the gas works. There is considerable objection to this scheme among the citizens.

Goldsboro, N. C.—A new electric light company has been organized.

Anniston, Ala.—Gas works will be built by the New York Contract Co., of New York City, and T. G. Foster, of Montgomery. The works will cost about $50,000, and they are to be completed in August. JULIUS LIPMAN is President of the gas company.

Greenville, Miss.—The City Council has accepted the bid of the Greenville Electric Light & Power Co. The city will be at once lighted by the Vanderpoole system by twenty-one 2,000-candle power arc lights. Private firms have agreed to take a liberal number of lights.

Little Rock, Ark.—The Citizens' Incan escent Electric Light Co. has increased its capital stock from $50,000 to $100,000. The plant will cost about $25,000. P. E. BRUGMAN is Secretary.

Wabash, Ind.—The City Council has entered into a contract with the Wabash Electric Light Co. to light the streets for a period of 5 years. There will be 127 lights of 30-candle power distributed over the city, the rental therefor being $2,300 per annum. The Heisler incandescent light will be used and the company will have it in operation by May 1.

Chicago, Ill.—Commissioner FRANK M. BLAIR, and Superintendent of Public Service JOHN BENHAM, the special committee appointed to investigate the practicability of uniting the city and county electric light plants, have reported favorably to the Public Service Committee. The plan is to shut off gas entirely in the County Building and connect the Jail and Criminal Court, as well as the Court-House, with the city's plant. The report showed that at present the cost per lamp in the City Hall is $5.07 per year, while in the county service the cost per lamp is $17.18¾ per year, including the cost of gas consumed at night, when the electric engines are not running. Under the consolidated plan the cost to the county would be $6.30 per lamp per year. The plan will probably be adopted.—The South Side Committee on Streets and Alleys has granted the Sun Electric Light Co. the right to lay wires, etc., for giving an electric light service to business houses from Adams to 22nd St., between the lake and river. The company is to furnish light to the city at actual cost, and pay 2½ per cent. of its gross receipts into the City Treasury.

Duluth, Minn.—The gas and water company will build new and larger gas works at Rice's Point, removing from the present location.

Merced, Cal.—An electric light plant is contemplated.

Water-Works.—*Maine.*—Saccarappa. A committee has been authorized to negotiate with the Portland Water Co. for water for fire purposes, and make a contract if water can be obtained for $3,000 per annum.

New Hampshire.—Franklin. A committee has been appointed to consider the question of putting in waterworks.

Massachusetts.—Riverside. The Riverside Aqueduct Co. is to be incorporated. Capital stock, $25,000.

New York.—Rochester. During 1887, 12 miles of pipe were laid; the city has now 187 miles of pipe and 1,713 hydrants.—Clyde. The question of putting in waterworks will be submitted to public vote.—Binghamton. This season 4¾ miles of pipe will be taken up and relaid and 1¾ miles of extension laid.—Albany. The Board of Finance has directed the issue of bonds for $200,000 for the purchase of engines, boilers and land, erection of buildings, etc., for the water supply.—Utica.—The Utica Water-Works Co. is increasing its capital stock by $100,000; subscriptions close April 16. J. H. CHAMBERLAYNE is Secretary.—Little Falls, N. Y. An appropriation of $50,000 is to be made for completing the system of water-works now under construction.

New Jersey.—Trenton. The Water Commissioners have ordered some extensions of the pipe system.

Pennsylvania.—Kutztown. Water-works are much needed and propositions will be favorably considered by the Council.—Allentown. The new water-works are approaching completion; the supply is taken from the old wells and will be sufficient for a population of 100,000. There are 2 Knowles pumps with a daily capacity of 3,000,000 galls. each. The city purchased the franchise of the Allentown Water Co. about 20 years ago and has operated the works successfully. The new works will cost about $70,000.

Ohio.—Springfield. A syndicate has made an offer to purchase the city water works for $500,000. JOHN A. FUNK is interested.

Indiana.—Indianapolis. The water company will make considerable improvements this year. Two new engines are being put in, their aggregate daily capacity will be 12,000,000 galls. Larger mains will also be laid on many streets.

Virginia.—South Boston. Proposals are invited for putting in a system of water-works. Address A. VENABLE.

West Virginia.—Charleston. The Charleston Water-Works Co. has been authorized to lay its pipes across the Elk river.—Huntington. It is not yet certain whether the works will be accepted, as it is claimed the fire streams cannot be thrown to the specified height.

Georgia.—Albany. Water-works and an electric light plant are projected. The cost is estimated at $35,000 to $40,000.

Tennessee.—North Athens. The water-works are nearly completed. The supply is drawn from a spring and pumped by steam to a stand-pipe on a hill.

North Carolina.—Goldsboro. The negotiations for water-works have fallen through, and new proposals will be received till April 25. Address N. O. Berry.

South Carolina.—Anderson. It was reported that the water supply had been exhausted at a recent fire; the Chief of the Fire Dept. has contradicted this and says the water supply is ample.—Winnsboro. A system of water supply is proposed.

Alabama.—Eufaula. The injunction case against the water company was settled March 22. The city council inspected the works and formally accepted them.—Warrior Station. Address R. H. PEARSON with regard to projected water-works.

Michigan.—Mt. Clemens. A proposition has been made to bond the city for $50,000 for water-works. Another proposition is to make the amount $125,000 and to draw a supply from Lake St. Clair.—Ithaca. Water-works are to be put in. The plans are being prepared by MASON L. BROWN, C. E., of Detroit.

Illinois.—Staunton. The water bonds for $6,000 will be put on the market May 1.

Minnesota.—Minneapolis. It is claimed that the fire protection is inadequate, owing to the mains being too small. The Board of Trade has recommended that new and larger mains be laid in the business part of the city.

Iowa.—Ottumwa. There is complaint of the bad quality of the water supply and the water company is urged to put down artesian wells. Several private wells have struck a good supply.

Wisconsin.—Hayward. The court has granted an injunction to restrain the town from building waterworks; the ground of the decision was that the town had no power to engage in such an enterprise.

Dakota.—Watertown. By the franchise granted last year the city was to pay an annual rental of $4,300 for water for parks and fire protection; last week the city council increased the amount to $7,100, but there is great opposition to the measure and the mayor has been asked to veto it.

Kansas.—Emporia. The new water-works are in operation. The cost was $160,000.—Conway Springs. A water company has been organized. E. W. DEMING is interested.—Chetopa. A proposition to build waterworks has been made by Nesbit & Campbell, of Larned. The cost would be about $45,000, and there would be 50 hydrants at a rental of $50. The test is to be for 4 streams 80 ft. high.

Nebraska.—Edgar. The water bonds were carried March 30 by a large majority.

Texas.—Galveston. The preliminary work has been commenced for drilling the first two wells. Mr. Brown, who put down the large well at Columbia, S. C., will be in charge of the work for LOUIS SIEGEL, of New York the contractor. Material is being delivered, and work will be commenced shortly on the pumping station.

Canada.—Kingston. An expenditure of $140,000 has been voted for improving the water-works.

The Excelsior Electric & Water Co. has been incorporated at Excelsior, Minn., with a capital stock of $50,000. President, A. W. LATHAM; Vice President, E. R. PERKINS; Secretary, A. E. APGAR; Treasurer, E. P. BREMAN.

The West Pueblo Ditch & Reservoir Co. has been incorporated at Cincinnati, O., by A. C. HAYDEN, C. H. SMALL, W. H. MORLEY, E. H. DIVELOISS and GEO. H. BAILEY. Capital stock, $3 600. The company will operate in Colorado.

Sewerage.—*Pemaquid, Me.*—The Pemaquid Land Co. will establish a drainage system.

Brooklyn, N. Y.—The Citizen's Protective Association of the 16th, 18th and 21st Wards (the flooded district) is agitating for sewers to drain this district. Plans for this purpose have been prepared by City Engineer VAN BUREN, and were submitted to the Board of Aldermen 3 months ago, but no action has yet been taken.—During the season the city will build sewers in North 2d St., at a cost of $100,000; in 40th St., $21,000; in Bond St., $9 500; in Sackett St., $2,500.

Bath Beach, N. Y.—A bill for a system of sewers is now before the State Legislature, the work to be under the supervision of a Commissioner. The main sewer will be on Cropsey Ave. and is estimated to cost $10,000. The scheme is backed by the Bath Beach Association, including W. W. CROPSEY, GEO. E. NOSTRAND, ELISHA KINGSLAND, and others.

Oneida, N. Y.—Plans for a sewerage system have been submitted by W. RANDALL, C. E.; estimated cost, $155,000, and by J. H. EHREHART, C. E., of Utica. EMIL KUICHLING, C. E., of Rochester, will be consulted with regard to the sewerage and the sewage disposal.

East Orange, N. J.—The Township Committee reports that the disposal works are nearly ready and connections will be made with the sewers as soon as weather permits. The larger part of the system will be in working order in 2 months.

Clifton, O.—It is proposed to issue 5 % bonds for $100,000 for extending the sewerage system and improving the streets.

Cleveland, O.—The Walworth run improvement is to be started at once; a large sewer will be built for the stream to flow through and a first-class avenue constructed over it. The City Engineer has been directed to prepare surveys for a proper system of sewerage.

Nashville, Tenn.—City Engineer JOWETT has prepared the plans and specifications for two 42 in. brick sewers to cost $5,000 and $6,500, and an extension to cost $7,500. Contracts will be let soon. More sewer work will be done this year than last.

Jackson, Tenn.—The question of establishing a system of sewerage is being agitated.

Key West, Fla.—Plans and specifications will be prepared shortly for the new sewerage system.

Orlando, Fla.—A system of sewerage is projected. Address Alderman BIRNBAUM for particulars.

Fort Madison, Ia.—A sewerage system is projected, to replace the present surface drainage.

Atchison, Kan.—A system of sewerage is to be designed by Rosewater & Christie, of Omaha, Neb.

Santa Cruz, Cal.—The City Council has approved the plans prepared by A. T. HERRMAN, under the supervision of GEO. W. WARING, Jr. From the 8 in. vitrified pipe main sewers, the sewerage will be pumped up 50 ft. to the top of the bluff, whence it will run by gravity to the ocean through a 12 in. pipe. The estimated cost is $30,000.

Stockton, Cal.—The city council has approved plans for a "separate system" of sewerage. Work will be commenced soon.

Artesian Wells.—*Earl Park, Ind.*.—At this watering station on the Cincinnati, Indianapolis, St. Louis & Chicago Ry., the company is sinking an 11-in. well.

Savannah, Ga—There are now 14 wells at the waterworks, and 4 more are being drilled; of the 14 wells 10 are 6-in., 1 is 4 in. and 3 are 10-in. diameter; they supply 6,000,000 galls. per day, which is about the average summer consumption.

Albany, Ga.—The county well, in the court house plaza, has been cleaned out and drilled 50 ft. deeper. The flow is now about 18 galls. per minute.

Birmingham, Ala.—The American Well Works, of Aurora, Ill., are drilling 4 wells for the Birmingham Rolling Mill Co.

Sonoma, Cal.—An artesian well put down by S. Shocker, struck water at 200 ft. The stream rises 6 ft. above the ground.

Grant, Neb.—An artesian well is to be put down; it will be sunk 3,000 ft. if necessary.

Morgan, Tex.—The Morgan Water-Works & Ice Co. has struck a flow of good water at a depth of 550 ft. The company will build a reservoir, and lay a system of pipes in the business part of the town.

Bonham, Tex.—The artesian well of the Texas & Pacific Ry. Co., has been sunk 800 ft. and has now a flow of about 21,000 galls. per day. It is thought 25,000 to 30,000 galls. can be pumped. This ensures the success of the new water-works, the contract for which was let recently.

Sherman, Tex.—Tests are being made for new wells for an additional water supply. Superintendent HARVEY stated that there are now 48 wells, but some of them are defective and do not furnish the proper amount. About 50,000 to 75,000 galls. is the average daily pumpage.

Houston, Tex.—The water company has put down a fourth well. The water is flowing freely from the other three.

Galveston, Tex.—The sites for the first two wells have been selected and the contractor, Louis Siegel, of New York, will commence work on these at once. There are to be 10 wells, placed 800 ft. apart, and they will be on the line of Winnie St.

Cedar Rapids, Ia.—The artesian well at the waterworks is 536 ft. deep, 5½ ins. bore; a good record for 12 days' work.

Deming, N. M.—The artesian well has been put down 850 ft. without striking water. The contract is for 900 ft.

Davisboro, Ga.—An artesian well is to be put down by L. B. CLAY, of Barton.

An Artesian Well in Australia.—The great drawback in Australia is the scarcity of water: but in Queensland a subterranean supply has been found. It is in a sandy district badly off for water. A 12 in. hole was sunk; some water was found at 645 ft. from the surface, then the drill passed through 7 ft. of sand, 115 ft. of stiff blue clay and then into a hard sand-stone rock. Below this last, water was struck which rose to the surface of the bore-hole at the rate of 508,000 galls. per day. The well only cost the Government $3,875.

Taunton, Mass.—The Water Commissioners have revised and reduced the meter rates, and the rates are now as follows, as given in a pamphlet of rates and regulations: when for each quarter the quantity consumed shall average less than 1,000 galls. per day, 25 cts. per 1,000 galls.; between 1,000 and 5,000 galls. per day, 20 cts.; between 5,000 and 20,000 galls. per day, 15 cts.; 20,000 galls. or over, 12½ cts. In no case where a meter is used shall the annual charge be less than $10, which sum must be paid in advance.

Ashland, Wis.—The Ashland Water Co. was incorporated in 1884, and the first regular supply was given the city in February, 1885; 20,000 ft. of mains being put in the first year. The pumping station is located on the bay front, and the water is conveyed to the pump well by a 16-in. pipe extending about 2,100 ft. into Chequamegon bay. There are 2 Holly-Gaskill engines, pumping direct to the mains. The ordinary pressure is 40 lbs., fire pressure 140 lbs. Daily pumpage about 500,000 galls. There are about 8 miles of pipe and 72 double nozzle hydrants. About 5,000 ft. of new mains will be laid this season. A considerable amount of sewer and street work, will also be done this spring.

Garbage Disposal.—At Ealing, Eng., a refuse destructor for disposing of the sewage sludge and house refuse of about 20,000 people is in constant use. No fuel save ordinary house refuse is used, and no fumes of an objectionable nature are produced. The sewage is treated by a lime precipitation process, the effluent passing into the Thames. The sludge and house refuse are cared for satisfactorily, by taking all the garbage, consisting of street sweepings, house refuse and the like, to the depot and dumping it into large bins. It is spread in layers about 12 ins. thick, and some of the sewage sludge is pumped upon it. Another layer of dry refuse is spread, more sludge is added, and this is repeated until the bin is filled. This is permitted to remain from 6 to 10 days as seems necessary. Farmers are then permitted to cart away as much as they wish to use for manure, no charge being made. What remains untaken is burned in the destructor. All refuse brought to the depot is disposed of as described at an expense of about 19 cts. per ton.—*Builder & Decorator.*

Liverpool, England.—The Water Committee has awarded contracts for work in connection with the Vyrnwy water supply. The work includes iron and steel for a tank 80 ft. diameter, miscellaneous iron work, large stopcocks, etc.; hydraulic lifts and engines. Also for sinking shafts and constructing a tunnel through the boulder clay formation to carry the Vyrnwy aqueduct beneath the river Mersey; the contractors were required to have had experience in tunneling and in sinking large cylinders through water-bearing gravel and alluvium.

Annual Reports.

Waterbury, Conn.—The Water Commissioners have issued their report for 1887, being the 21st annual report. During the year 18,818 ft. of 4, 6, 8, 16 and 18-in. pipe were laid and 15,586 ft. taken up and discontinued, 29 gates set and 10 taken up, 23 hydrants set and 11 taken up. There are now in use 106,907¾ ft. of 1 to 18-in. iron pipe, and 79,175¾ ft. of 3 to 20-in. cement pipe, total 186,683½ ft.; 298 gates, 236 hydrants (36 private); there are 128 meters in use. WELTON & BENNET are the Engineers.

Erie, Pa.—The Water Commissioners have issued their report for 1887. A new Gaskill engine of 5,000,000 galls. capacity was put in by the Holly Mfg. Co., of Lockport, N. Y., and tested in April. The total pumpage for the year was 1,218,213,688 galls. During the year the pipe extensions were 22,077 ft. of 1 to 12-in. pipe, and 1,399 ft. taken up and relaid, total in use 56 miles 2,916 ft.; 40 additional hydrants were set, total 318; 58 stop valves set, total 526; 12 meters set, total 76. Total number of consumers 6,367. There are 2 Cornish pumps, 20¾-in. plungers, 10 ft. stroke, and the new Gaskill engine. The reservoir is about 2 miles from the pumping station and the bottom is 210 ft. above the surface of the bay. The stand-pipe is 251 ft. high. The report includes tables of engine performance, etc., and a list of water rates in 162 cities where meters are used: the average minimum price is 9¼ cts. per 1,000 galls. and average maximum price 28 cts. GEO. W. STARA is President, and B. F. SLOAN, Secretary of the Commission.

Manchester, N. H.—The Water Commissioners have issued their report for 1887. Two new Risdon waterwheels, of 175 H. P. each were put in by T. H. Risdon & Co. The new Davidson pumps pump 5,000,000 galls. per day, and the old pumps are in good condition. The total pumpage was 615,061,314 galls. During the year about 1½ miles of pipe were laid and the city has now 49.14 miles, of which 26.69 are of wrought-iron and cement, and 22.45 of cast-iron; 14 hydrants and 12 gates were set; there are now 418 hydrants and 365 gates, also 7 air valves; 126 meters were added making a total of 739. CHARLES K. WALKER is Superintendent.

Bradford, Pa.—The Water Commissioners have issued their report for 1887, being the 6th annual report. The new reservoir, with a capacity of 20,000,000 galls., was completed in October; $11,244.23 was paid to J. & M. McMahon, the contractors, and the total cost including connections, engineering, and alle xpenses, was $17,770.17. The plans for the dam were made by J. A. SEYMOUR, City Engineer. The storage reservoir used with the old system was sold. The distribution system comprises 83,209 ft. of 1½ to 14-in. pipe, 192 gates and 57 hydrants. C. J. LANE is Superintendent.

Poughkeepsie, N. Y.—The Water Commissioners have submitted their report for 1887, being the 19th annual report. During the year 363 ft. of 6-in. main were laid, and the city now has 18 402 miles of 4 to 27-in. cast-iron pipe. There are 530 meters. The total amount pumped during the year was 644,858,358 galls., of which 68,800,000 galls. passed through the 530 meters, and of this latter quantity 33,290,000 galls. passed through 40 meters. It is recommended that new meters be purchased and the meter system applied to the whole city. CHAS. E. FOWLER is Superintendent.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(*Specially Communicated.*)

(CONTINUED FROM PAGE 260).

Waynesburg, Pa.—The works were commenced in September, 1887, and have been recently completed. EDWARD J. HARLOW was Constructing Engineer. James H. Harlow & Co., of Pittsburg, were the contractors. The reservoir is at an elevation of 385 ft. above the pumps. The franchise is owned by the Waynesburg Water Co.; Secretary, L. W. LINGLEY. The estimated population is 2,500.

Holden, Mo.—The works were commenced in March, 1887, and accepted Dec. 23d. The engineers were L. P. ANDREWS and J. B. QUIGLEY. The contract for the works was taken by the Inter-State Gas & Water-Works Co., of St. Louis. The standpipe is 127 ft. high. The franchise is for 20 years, with renewal unless purchased by the city; the hydrant rental is $60 per annum. The franchise is owned by Quigley & Co., of St. Louis, and the works are operated by the Holden Water-Works Co.; President, L. P. ANDREWS; Secretary, A. SCHENCK; Superintendent, B. J. MILLER. The population in 1887 was estimated at 4,500.

Cortland, N. Y.—The works were commenced July 5, 1887, and were accepted Oct. 22, 1887. They were designed by F. S. PECKE, and L. J. RICHARDSON was Constructing Engineer. The contractors were Moffett, Hodgkins & Clarke, of Watertown, N. Y. There are 14.7 miles of pipe. The franchise is exclusive, and is for 20 years. The works are owned by the Cortland Water-Works Co.; President, B. F. TAYLOR; Superintendent, L. J. RICHARDSON. The population in 1887 was 9,000.

(TO BE CONTINUED).